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ABSTRACT

Thirty deaf children admitted to an auditory training program before age 2 were studied longituninally to age 40 months in an investigation of the effectiveness of early intervention, the relationship between mother-child interaction and language acquisition, and the effectiveness of new devices developed for auditory training. Among findings were that Ss admitted prior to 16 months old showed greater language competence and that mothers of Ss with better language skills were less coercive and more sensitive and accepting to their children. Affective aspects of mother-infant interaction were more highly correlated with the child's language aquisition than were technical aspects of the mother's language. Devices developed to reinforce vocalization and to stimulate receptive language in Ss from deaf homes included a sound activated mobile and a Teddy bear. Problems such as technical difficulties and insufficient child interest led to the conclusion that the devices were of limited value. Subsequent experiments which provided direct auditory and speech training services to deaf parents seemed more promising. (Appendixes include the Lexington Preschool Oral Language Assessment, Mother-Infant Communication Rating Scales, and diagrams of the auditory training devices.) (LS)

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Final Report

Project No. H 0061 SJ

Grant No. OEG-0-72-5339

METHODS OF FOSTERING LANGUAGE DEVELOPMENT IN DEAF INFANTS

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SUMMARY

Thirty deaf children admitted to an auditory training program during the first two years of life were studied longitudinally to age 40 months. Those admitted prior to 16 months of age were found to show greater language competence. Children with better language skills looked more at their mothers at age two and their mothers were found to be less coercive and more accepting and sensitive to the child. Affective aspects of mother-infant interaction were more highly correlated with the child's language acquisition than were technical aspects of the mother's language. The results suggest a reciprocal interaction among maternal acceptance of the child, early intervention, and the child's language acquisition. Differences among hearing mothers, and between the deaf and hearing, suggest that there may be a normal flow of verbal and nonverbal communication with the child which is essential to language acquisition. The mother's discovery of her child's handicap may drastically disrupt this flow and the role of early intervention programs should be to facilitate its resumption.

Devices developed to reinforce vocalization and to stimulate receptive language in deaf infants from deaf homes were found to be of limited value. Programs which provide direct auditory and speech training services to deaf parents seem more promising.

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PREFACE

This project was conceived as a two-part investigation.

The purposes of Part I were: (1) to develop procedures for measuring the receptive and expressive language skills of hearing-impaired infants; (2) to use these procedures to evaluate the effectiveness of a program of early intervention; (3) to develop procedures for studying styles of communication and interaction between mothers and their hearing-impaired infants; and (4) to use these procedures to determine aspects of mother-infant interaction associated with rapid language acquisition.

The purpose of Part II was to develop and evaluate new devices for auditory training of hearing-impaired infants.

For clarity, Parts I and II are presented sequentially.

PART I

EARLY INTERVENTION AND LANGUAGE ACQUISITION IN HEARING-IMPAIRED INFANTS

CHAPTER I

INTRODUCTION

Much interest has been focused in recent years on the puzzling and seemingly miraculous manner in which the very young child acquires language. Some researchers (Chomsky, 1965; McNeil, 1970) have postulated an inherent capacity to apprehend and use linguistic structures. Others have focused on experiential determinants of language competence in early childhood. In these studies, normal and experientially deprived groups have often been singled out for study in the hope that they would provide sufficient variation in language competence for its precursors or determinants to be examined. For example, differences in linguistic output or complexity have been found between middle and lower class children (Hess & Shipman, 1965; Irwin, 1960) and between the institutionalized and home-reared (Brodbeck & Irwin, 1946), and enrichment procedures have been found to be effective in increasing output (Rheingold, 1956).

Determinants of Language Acquisition in Deaf Infants.

Surprisingly little use has been made of the severely hearing-impaired infant as a source of invaluable information regarding speech and language acquisition processes. In part, this under-utilization may be attributed to the limited availability of such populations for study. More relevant, perhaps, has been a lack of awareness of the extent to which advances in hearing aid technology and educational practices have permitted the acquisition of "natural" speech and language by the profoundly deaf child.

The variation in linguistic competence within the deaf population far exceeds that among the normally hearing. Some profoundly deaf children become expert speech-readers, acquire reasonably intelligible speech, and develop their reading, writing, and overall language skills to a level commensurate with their hearing peers. Others remain illiterate and seem unable to either understand or use oral communication with hearing people.

The determinants of this enormous variation are largely unknown. To attribute it to differences in innate intellectual or language gifts is to beg the question. It is often assumed

that such variables as residual hearing capacity, method of training, age at which intervention is begun, the degree of overall language input, and the nature of the mother-infant interaction are critically relevant, but little research has been done to separate out the relative contributions of each of these factors.

The "Oralism vs. Manualism" Controversy

Because of its practical educational relevance, the focus of much research has been on the methods-of-training issue. Unfortunately, this focus has more often been blurred than sharpened by the controversy between "oralism" and "manualism" among educators of the deaf. In one of the more thorough studies of this issue, Vernon & Koh (1970) attempted to ascertain the role of "early manual communication" in the achievement of deaf children. As is traditional in this line of investigation, a group of deaf adolescents whose parents were deaf and who presumably learned sign language early ("manual group") was compared to a matched group whose parents were hearing ("oral group"). Sample controls were instituted to minimize the initially higher likelihood that the oral group might contain more brain damaged or otherwise multiply-handicapped children (Vernon, 1969). While no differences were found between the groups in speechreading skill, speech intelligibility, or ratings of personal adjustment, differences favoring the manual group were found in achievement tests and in teacher ratings of written language skills. In a subsequent study, the same investigators (Vernon & Koh, 1971) compared three groups of deaf adolescents attending the California School for the Deaf. Again, a "manual group" (having deaf parents) was compared with two "oral" groups (having hearing parents): one which had no pre-school training and another which had three years of pre-school training at the John Tracy Clinic, a renowned oral education center. Again, no differences were found among groups in speech or speechreading skills or between the "oral" groups with and without pre-school on any of the measures. The "manual" group was, however, found to be superior in measures of achievement and academic success. The investigators conclude from these studies that "early oral training, even under optimal conditions, yields no better results than the absence of oral training and an oral environment" and that educational approaches which do not include manual communication are "destructive to deaf children."

The above studies have been cited because they are among the best of this genre of research comparing children of deaf and hearing parents, and to show how far-reaching conclusions are often based on the most tenuous chain of inference in this field. It is instructive to examine this chain of inference before designing further research bearing on this controversy, particularly since the investigations described have been considered to be of critical importance.

First of all, the inference is made that the most crucial distinction between a deaf child who has deaf parents and one whose parents are hearing is that the former is exposed to and learns manual communication earlier. This inference is based more on faith than evidence, however. Closer examination suggests that the trauma a hearing mother experiences upon discovering that her child is handicapped is of a different order than that experienced by the deaf mother. The latter has already formed an adjustment to deafness through personal experience and has psychologically prepared herself for the possibility that her child may be born deaf. In many instances, there are previous deaf children in the family. The hearing mother lacks this experience and preparation. The disruption of the normal mother-child pattern of interaction and communication engendered by this trauma may, in fact, have profound influences on the child's acquisition of communication skills.

Not only do the deaf and hearing parents differ on their emotional reaction to the discovery of their child's deafness, there is evidence that this very discovery is made at a later time among the hearing parents than among the deaf. Deaf parents, sensitized to the role of genetic factors, often bring their child in for diagnosis during the first months of life. Hearing parents often do not suspect deafness until the child's second year of life. There is widespread agreement on the crucial importance of the first years of life in language acquisition, but the investigations described above present no data on the performance of children whose compensatory training began considerably before three years of age. In fact, Vernon and Koh conclude that "speech instruction with deaf children pays its biggest yield when begun at regular school age." It may be, on the contrary, that their preschool sample began not too early but too late.

The difficulties of making far-reaching generalizations

based on such research methodology are further complicated when the effects of the variable under study (e.g., the influence of early manual or oral training) must be retrieved ten or fifteen years after its introduction. Although Vernon and Koh, in their reports, give no data on the current manual proficiency of the adolescents studied, it is strongly suggested that the "oral" children had acquired manual training, both formal and informal, by the time of their studies. The passage of such a great length of time presents many problems. Since only children still enrolled in a school for the deaf were studied, no data could be presented on the more "successful" deaf children whose early compensatory training permitted them to move into regular school classes with hearing children. The exclusion of this group from study is a significant biasing factor, since the trend towards integration of deaf children with high language competence into the regular school system has been increasing in recent years. Those remaining in a school for the deaf by adolescence reflect a selected sample of children with deficiencies in speech and language competence. Again, a study conducted on somewhat younger children at the Lexington School for the Deaf (Smith, 1973) yields findings at variance with those of the above investigators. In this study, the 20 children scoring above the median in speech intelligibility all came from hearing homes, whereas 9 of the 20 children scoring below the median were from deaf homes. The difference is statistically significant.

Even assuming the validity of the Vernon and Koh findings, their conclusions cannot refer to current preschool programs, but only to children exposed to a program fifteen years previously. To suggest otherwise would dismiss as inconsequential not only the gains in educational methods of the past decade but also the technological advances in hearing aids which now permit practical use of much more powerful amplification with very young infants.

Mother-Infant Communication Styles

These detailed criticisms of the two studies by Vernon and Koh are not presented because they are so poorly designed. On the contrary, they represent what is probably the best controlled and most sophisticated of a large number of "manual vs. oral" comparisons (Meadow, 1968; Stevenson, 1964; Stuckless & Birch, 1966). The context of this controversy between the two schools of deaf eduction has forced numerous investigators into strained research designs and polemical conclusions. The logic has often been forced to follow the path: "Children

of deaf parents seem to do better in some language measures than do children of hearing parents. Deaf parents use signs and do not talk much. Hearing parents talk and do not use signs. Therefore, hearing parents should be taught to use signs." Although the conclusion that "hearing parents should talk less" is as consistent with the premise given, most investigators have steered away from this alternative. The point is, of course, that the very questions posed lead to misleading, overgeneralized, or sterile answers.

A more productive approach would pose the question: "What is it that parents of very young deaf children do that facilitates or impedes speech and language development?" Such an approach would study how styles of communication between principal caretaker and infant influence language acquisition. It would focus on the variations of language competence within children from deaf and hearing homes, and not merely between them.

The Infant Center of the Lexington School for the Deaf

The setting for the project to be described is the Infant Center of the Lexington School for the Deaf, a combined diagnostic, educational, counseling, and research facility established formally in 1966 to provide services to New York Metropolitan area residents who have severely hearing-impaired children under three years of age.

The basic thrust of the program is towards parent education and counseling and early remediation for the child. Parents may be self-referred or referred by other agencies or professionals when a child is suspected of having a hearing loss. An audiological examination is scheduled within a week of referral at the Lexington Hearing Center. Testing of infants is performed by a staff of three audiologists using impedance and conventional audiometric techniques (sound field, conditioned orienting response, or serial play) appropriate to the age of the child. If the child is suspected of having a severe hearing loss (greater than 70 dB throughout the speech range), parents are referred to the Infant Center. Following confirmation of the initial diagnosis and otological examination, the child is fitted with earmolds and binaural post-auricular hearing aids.

From this point, the parent is scheduled with the child for a once-a-week 90-minute session with one of two Infant Center

teachers (each certified in early childhood and deaf education). These sessions are aimed at helping the child to make maximum use of his or her residual hearing. The auditory training program is similar to others described in the literature (Harris, 1971; Northcott, 1972; Pollack, 1970), but is tailored to the individual needs of the family. The educational philosophy is heavily parent-centered--the goal being to equip the parents to stimulate as much as possible the child's affective, cognitive, and language development.

In addition to the weekly individual sessions, parents and other family members attend a series of workshops, usually given on Sunday afternoons, in which lectures and discussions are held on topics related to child development, the hearing system, auditory training, audiological assessment, hearing aids, language development, and speech. Periodic workshops on specific techniques of language development and child management are also offered throughout the school year.

A major emphasis of the program is its emphasis on providing emotional support for parents undergoing the traumatic discovery of the child's hearing handicap. To help parents make this difficult adjustment, they may participate in weekly group sessions in which they share feelings and problems related to themselves, their child, and his condition. A mental health team (psychiatrist, psychologist, and psychiatric social worker) provide supervision for the teachers in working with parents both individually and in a group.

Parents and their children, once admitted to the Infant Center, generally remain until the child reaches the age of three. At this time, the child may enter the regular Lexington nursery school (which contains a number of hearing children) or be integrated into a regular hearing nursery school.

Plan of the Research

The study to be described attempts to provide partial answers to the following questions: (1) How effective is intervention during the first three years of the life of the hearing-impaired child?; (2) Is there a "critical period" during which such intervention is maximally effective; (3) What aspects of the early mother-infant communication system are most relevant to the deaf child's acquisition of language?; and (4) How may early intervention programs be

designed to foster those aspects of mother-infant communication or interaction which facilitate language acquisition.

Ideally, a research design for studying the effectiveness of early auditory training would require random assignment of hearing-impaired children into training and no-training groups. The effects of amplification, training, and counseling might also be isolated experimentally. Since practical as well as ethical considerations contraindicate such a design, research in this area is forced to tolerate the ambiguities of correlational methods

In the Lexington School Infant Center, children are introduced to amplification and training, and their parents to counseling and education, as soon after diagnosis as possible. Thus, the separate effects of these variables cannot be isolated. Effects of length of time in the program, age at admission, and any selective factors affecting age at diagnosis may all interact in a complex manner.

Furthermore, the problem of studying the effectiveness of any intervention program is complicated by the length of the program and the length of the project. Some children entered the Infant Center too late for inclusion in the longitudinal study. Others were still in the program at the time of the project's termination. Thus, along with the usual limitations of correlational and field studies, the project was also forced to work with relatively small samples.

Since so little research has been done in this area, it was decided to tolerate these limitations in order to make beginning inroads towards answering the questions posed.

The basic plan was to design or adapt instruments appropriate for measuring language skills in the children and modes of mother-child interaction and communication. The effectiveness of early intervention was studied by following through to 40 months of age two groups of children: a group admitted prior to 16 months of age and a group admitted between 16 and 24 months of age. Measures of mother-infant communication were correlated with each other and with language measures obtained at 24, 30, 36, and 40 months.

CHAPTER II

METHODS

Subjects

Subjects for the study consisted of 30 children diagnosed as severely or profoundly hearing-impaired who were admitted to the Infant Center of the Lexington School for the Deaf prior to their second birthday. The degree of hearing impairment of the group was measured by averaging the two best responses of the child to pure tones of 500, 1000, and 2000 Hz (S.P.L.). Only children with hearing losses of 70 dB or greater were included in the study.

Of the 30 Ss, 11 came from homes in which both parents are deaf and 19 from homes in which both are hearing. The average age of admission for the children of deaf parents, as shown in Table 1, is approximately 10 months earlier than for children of hearing parents. This means that such children have 10 months longer experience with hearing aids and exposure to the auditory training program. In order to help separate effects of early admission (and longer exposure) to the program from parental hearing status, the children from hearing homes were divided into an Early Admission group (n=9) and a Late Admission group (n=10), with 16 months of age being the division point. Hollingshead's (1957) Index of Social Position was used as a measure of socioeconomic status (SES) to check the possibility that the parents of the Early Admission group may have been better educated or had superior economic opportunities. As expected, the hearing parents had a significantly higher SES than the deaf parents, but no other significant differences in SES or hearing threshholds were found among the subgroups.

Table 1

Audiometric and Sociometric Data on Subjects

	N	Age (in Months) at Admission	Mean SES	Pure Tone Averages (dB)	
				Unaided	Aided
Deaf Parents	11	7.27	3.73	96.55	54.45
Hearing Parents	19	17.20	2.74	100.69	47.47
Early Admission	9	12.67	2.78	95.67	42.44
Late Admission	10	20.90	2.70	105.20	52.00

Measures of Child Language Skills

Since children under three years of age do not respond to conventional, standardized tests of receptive and expressive language development, observational methods must be relied on. Even after three years, when the child may be tested in a standardized situation, scales appropriate for measuring oral receptive and expressive language of deaf children are not available. Consequently, it was necessary to rely on teacher observation for assessment of child language skills up to three years of age and to develop a new test procedure for three-year-olds.

Teacher Observation (REEL Scale)

The Receptive-Expressive Emergent Language (REEL) Scale (Bzoch & League, 1971) is a standardized scale, based on teacher observation or parent report, originally designed for assessing the communication skills of normally hearing children up to three years of age. The scale was completed by the teacher at six-month intervals on the child's birthday and at mid-year (e.g., 12, 18, 24, 30, and 36 months) up to three years. A slight modification was necessary in the scoring system to account for the greater spread of scores among the hearing-impaired. The scoring manual assigns a receptive and expressive language age (RLA and ELA) based on the last age interval in which two pluses were recorded. In the present study, all items were scored and given appropriate weighting depending on the number of items in an age interval. The teachers based their scoring on weekly sessions with each individual child. This, along with the alteration of the scoring system permitted more sensitive measurement than would have been obtained from the usual scoring procedure based on parent report.

Lexington Preschool Oral Language Assessment

The Lexington Preschool Oral Language Assessment (POLA) is a procedure designed to measure the speech and language competence of three-year-old hearing-impaired children. Designed for children who are currently aided and who have received some prior auditory training, the procedure resembles a familiar play situation with an adult tutor.

In its full version, administered to 20 of the 30 Ss in

the study, the scale required approximately 40 minutes to administer. The scale which was administered when the children were 40 months of age ($\pm$ 2 weeks), consists of a series of play situations with familiar toys (Jack-in-the-box; baby doll undressing; bathing the baby; feeding baby; putting baby to bed; play with small and large toy cars; taking doll family for a ride; play with toy airplane, flashlight, and ball; talking on the telephone; opening a latchbox to find animals; identifying animal sounds; and identifying objects in a story).

The play situations follow a standard script providing 311 scorable items classified into four scales:

D (Directions) Scale: These 69 items are orally given requests for the child to perform specified actions. They are spoken only when the child is attentive and looking at the face of the examiner.

A(Auditory) Scale: These 37 items are directions given to assess the child's use of residual hearing. They are spoken with the hand masking the lips.

E (Elicitation) Scale: These 106 items are questions aimed at eliciting an appropriate oral response from the child.

I (Imitation) Scale: These 99 items are words spoken in an effort to elicit vocal imitation from the child.

Items in the D and A Scales assess receptive oral language and items in the E and I Scales assess expressive oral language.

Each item is scored as 0, 1, or 2 (see Appendix for scoring instructions).

Measures of Mother-Infant Communication and Interaction

Assessment of mother-infant communication and interaction was obtained from two sources:

(a) Observation of mother and infant behavior in a series of laboratory situations; and

(b) Teacher ratings based on prolonged observation of mother and child.

These procedures are described below.

Observational Assessment of Mother-Infant Communication (OAMIC)

The "Observational Assessment of Mother-Infant Communication" is a 20-minute videotaped series of situations in which mothers are asked to communicate with or to elicit communicative behavior from their child. The situations provide a standard laboratory setting during which the language and communication behavior of both child and mother may be assessed in a variety of ways. It is administered within a month of the child's second birthday.

The mother was informed, prior to the observational assessment, that the purpose of the procedure was "to make sound and video recordings of the infant's behavior" and "to see how hearing-impaired children of different ages communicate with their parents."

Mother and infant are led into the observation playroom, a 9-foot square room containing a chair, a small table on which some magazines are spread, and a toy cupboard. A 6' x 4' one-way observation window permits visual observation of the playroom from a small observation and recording room. Two microphones on the playroom walls are connected to an audio tape recorder and videotape recorder in the observation room. A wide-angle lens on the video-camera permits coverage of the entire playroom as well as of a timing device mounted on the observation room window. One observer monitors the time and video signal, giving a narrative audiotape description of events which may not be clear on the videotape, while another observer records infant looking behavior on an event recorder.

The assessment procedure is divided into six segments, as follows:

(1) Unstructured Interaction (5 min.)

The mother is told by E, upon entering the playroom, "Make yourself comfortable. Your child may play with whatever toys he wants to. You can sit here and watch or read, or you can play with him. Whatever you wish. I will be back in a few minutes."

The purpose of this segment is to record a five-minute sample of mother-infant interaction and infant language behavior under relatively unstructured circumstances.

(2) Behavior Elicitation (2 min.)

E returns after five minutes with a large cardboard box and says to the mother, "We would like your child to put the toys into this box. Try to get him to do it in any way you think he will understand. If you wish to use signs or gestures to help him understand what you want him to do, that will be okay."

The purpose of this segment is to observe how the mother communicates and attempts to elicit behavior from her child, and how the child responds to these attempts.

(3) Expressive Language Elicitation (3 min.)

E says: "Now we would like to tape your child communicating with you in whatever way he does it. Try to get him to communicate with you, with sounds or gestures, in some of the ways he does it at home."

The purpose of this and subsequent segments is to assess the child's language or imitative behavior under circumstances where the mother attempts directly to elicit it. The mother's typical mode of eliciting language is also assessed.

(4) Receptive Language Elicitation (3 min.)

E says: "We would like to see how much language he understands. Try to get him to show that he understands you when you use words or gestures to ask him to do something."

(5) Imitation Elicitation (2 min.)

E says: "We would like you to get him to imitate you. You may do anything you think of to get him to imitate you."

(6) Separation (0 to 5 min.)

E says: "We would like to see what he does when you leave the room. If he is upset after you leave the room, we will call you back in."

The purpose of this segment is to assess how the mother communicates her attempt to separate; the child's separation, stranger, and isolation anxiety; and mother-infant reunion behavior.

If the child cries when the mother leaves the room, this segment is terminated and the mother called back in immediately. If the child shows no distress, he is observed for two minutes, during which E sits in the chair, responding passively. If this two-minute segment has not been terminated by distress behavior, E leaves the room and the child's isolated behavior is observed for two minutes or until he shows distress. Following this period E returns with the mother and their reunion behavior is observed for one minute.

The five-minute Unstructured Interaction period is divided, for scoring purposes, into 30 ten-second intervals. During each interval, the presence or absence of each of the following behaviors is scored: (1) child looks at mother; (2) mother looks at child; (3) simultaneous eye contact (vis-à-vis); (4) child vocalizes; (5) mother talks; (6) child gestures to mother; (7) mother gestures to child; (8) child moves towards mother; (9) child moves away from mother; (10) mother moves towards child; (11) mother moves away from child; (12) child touches mother; (13) mother touches child for attention; (14) mother touches child for comfort; and (15) average distance of mother from child.

Each utterance of the mother is also analyzed, with the following variables scored: (1) number of utterances; (2) number of words; (3) average length of utterance; (4) number and percent of utterances using the child's name; (5) number and percent of interrogative utterances; (6) number and percent of word repetitions; (7) number and percent of utterances attended to by the child; (8) number and percent of directions; (9) number and percent of directions responded to by the child; (10) number and percent of utterances related to the child's actions; (11) number of rewarding utterances; (12) number of critical or inhibitory utterances.

The following maternal variables are scored during the behavior elicitation segment of the OAMIC: (1) presents model behavior; (2) use of gestures; (3) use of physical coercion; (4) success in getting attention; (5) success in communicating task; and (6) adaptiveness. During the remaining language, imitation, and separation segments, the child is scored for: (1) responds to name; (2) responds to negative commands; (3) responds to oral directions; (4) gestures to indicate wants; (5) vocalizes to indicate wants; (6) jabbers expressively; (7) imitates vocalizations; (8) imitates gestures; and (9) cries during separation.

Mother-Infant Communication Rating Scales

When an Infant Center child reaches three years of age, the teacher assigned to the family completes a 33-item rating scale covering a range of variables related to (1) the mother's language behavior, (2) her relation to her child, and (3) her response to the Infant Center program. Each item is scored on a five-point scale from poor to excellent (see Appendix).

CHAPTER III

RESULTS

Effectiveness of Early Intervention

Table 2 presents mean language scores of the children of deaf and hearing parents admitted to the Infant Center before and after 16 months of age. Mean differences in receptive, expressive, and total language scores on the REEL Scale at 24, 30, and 36 months and the Lexington POLA scale at 40 months were compared by means of a one-way analysis of variance. The overall F-ratio was then broken into two orthogonal comparisons: (1) early vs. late admission (with deaf and hearing parent groups combined) and (2) early admitted children of deaf vs. hearing parents.

Among children admitted before 16 months of age, mean differences in receptive and expressive language between the children from deaf and hearing homes are small and non-significant at all age levels. In contrast, the early admitted children are consistently superior to the later admitted children in all aspects of language at all age levels. Differences between these groups, while consistent throughout ($p < .10$ on all comparisons) appear largest in expressive language, where they show consistent statistical significance.

While these data clearly refute the hypothesis that very early intervention has no effect on the hearing-impaired child, the explanation of these differences is more problematic. The most plausible interpretations are:

(1) Parents who bring their children in earlier for diagnosis and remediation may be more sensitive, concerned, or have other personality characteristics which facilitate their children's language acquisition;

(2) There is a critical period for early intervention, possibly at or before 16 months, so that children aided before this age respond better than those aided later;

(3) Auditory aiding, training, or other factors associated with the Infant Center intervention program (possibly including even the mere passage of time after diagnosis) have an additive effect, such that longer exposure to these conditions

Table 2

Mean REEL Scale Language Ages and Lexington POLA Scores of Subjects at Four Age Levels

	Early Admission		Late Admission	F Ratios		
	Parent Hearing Status			Total	Early vs. Late	Deaf vs. Hearing
	Deaf	Hearing	Hearing			
REEL(mos.)	RECEPTIVE LANGUAGE					
24	12.89	12.78	8.22	2.44	4.87*	< 1
30	18.22	16.31	12.95	1.91	3.33	< 1
36	19.81	20.38	16.55	1.29	2.53	< 1
POLA						
40	115.33	103.83	86.62	2.01	3.48	< 1
AUDITORY	27.67	24.50	16.75	1.91	3.56	< 1
DIRECTIONS	87.67	79.33	69.88	1.36	2.20	< 1
REEL	EXPRESSIVE LANGUAGE					
24	12.78	12.64	8.50	2.70	5.40*	< 1
30	18.24	18.64	14.24	2.01	3.99	< 1
36	21.67	20.60	15.76	2.88	5.60*	< 1
POLA						
40	257.50	202.67	120.50	4.69*	8.11*	1.27
ELICITED	106.50	74.33	40.50	5.32*	8.45**	2.19
IMITATIVE	151.00	128.33	80.00	3.58	6.57*	< 1
REEL	TOTAL LANGUAGE					
24	12.83	12.71	8.36	2.80	5.60*	< 1
30	18.23	17.47	13.59	2.04	3.97	< 1
36	20.73	20.48	16.15	2.11	4.22	< 1
POLA						
40	562.50	514.00	442.62	3.94*	6.79*	1.09

*p < .05
**p < .01

facilitates language acquisition; or

(4) Some combination of all of the above.

It may be noted, relevant to the above hypotheses, that the differences in language competence noted at 24 months do not "wash out," even after 16 months of training. While the data are insufficient to warrant broad generalizations and it would certainly be worthwhile to follow the three groups further longitudinally, the failure of the gap between the early and late groups to narrow would argue against hypothesis (3) above.

Unfortunately, the sample studied was too small to test the critical period hypothesis more thoroughly. Collection of more data on children, particularly from hearing homes, who are aided before 16 months of age might isolate the age period, if one exists, during which intervention is maximally effective.

Distinguishing among the other hypotheses cannot be accomplished further by looking at group differences. A more fruitful approach might be to study the specific variables associated with early language development.

Mother-Infant Communication

Table 3 presents an analysis of variance for OAMIC behavior during the free interaction period. Aside from greater number of vocalizations by hearing mothers, no significant differences are present between the children of hearing and deaf parents admitted before 16 months of age. In contrast, the styles of communication between mother and child for early and late admitted children show striking differences. Children admitted after 16 months of age look at their mothers less frequently and there is less simultaneous visual regard. They also vocalize significantly less often and show less movement towards their mothers. Mothers of early admitted children (particularly but not exclusively the deaf) also tend to use more gestures.

As can be seen from Tables 4 and 5, many of these very same behaviors appear to be the ones most highly correlated with language competence. Children who show consistently high language scores across the 16 month longitudinal period tend to look at their mothers more frequently and to move towards

Table 3

Mean Differences in Mother-Infant Communication Behaviors at 24 Months Related to Age of Intervention and Parent Hearing Status

Variable	Early Admission		Late Admission	F Ratios		
	Parent Hearing Status			Total	Early vs. Late	Deaf vs. Hearing
	Deaf	Hearing	Hearing			
Looking						
Child at Mo.	17.71	14.00	10.30	4.71*	7.22*	2.20
Mo. at Child	23.79	27.67	23.50	1.64	<1	2.58
Simultaneous	15.57	12.89	8.40	4.49*	7.80**	1.18
Vocalizing						
Child to Mo.	10.07	9.67	4.60	2.41	4.80*	<1
Mo. to Child	16.64	26.67	22.90	6.51**	<1	12.18**
Gesturing						
Child to Mo.	3.07	3.78	1.40	<1	1.72	<1
Mo. to Child	13.00	7.67	4.50	5.07*	6.57*	3.57
Movement						
Child Total	10.50	10.11	8.70	<1	<1	<1
Towards Mo.	3.64	2.89	1.80	2.61	4.41*	<1
Mother Total	4.57	4.11	5.80	<1	1.03	<1
Towards Child	2.14	1.67	2.70	<1	<1	<1
Touching						
Child	0.57	1.33	0.10	2.02	2.28	1.76
Mother	4.07	5.44	4.10	<1	<1	<1
Distance	0.90	0.62	0.68	<1	<1	1.65

*$p < .05$
**$p < .01$

Table 4

Correlations Between OAMIC Behavior at 24 Months and Child Language at Four Age Levels (All Ss)

	REEL Scale			POLA
	Months			
	24	30	36	40
Looking				
Child at Mother	.62**	.54**	.32	.52*
Mother at Child	.47*	.10	.17	.00
Simultaneous	.60**	.55**	.40	.46*
Vocalizing				
Child to Mother	.29	.15	.31	.42
Mother to Child	.09	-.17	-.18	-.30
Gesturing				
Child to Mother	.44	.24	.08	.13
Mother to Child	.37	.16	.00	.23
Movement				
Child	.27	.34	.23	.30
Towards Mother	.50*	.51*	.29	.25
Mother	-.37	-.45*	-.54**	-.20
Towards Child	-.21	-.32	-.44*	-.06
Touching				
Child	-.02	.04	-.08	.16
Mother	-.12	-.17	-.53*	-.35
Distance	.20	.13	.25	.31

*$p < .05$
**$p < .01$

Table 5

Correlations Between OAMIC Behavior at 24 Months and REEL Scale at Three Age Levels (Hearing Parents Only)

	REEL Scale Language at:		
	24 Mos.	30 Mos.	36 Mos.
Looking			
Child at Mother	.71**	.75**	.42
Mother at Child	.46	.32	.53*
Simultaneous	.67**	.81**	.55*
Vocalizing			
Child to Mother	.40	.11	.26
Mother to Child	.44	.38	.27
Gesturing			
Child to Mother	.48	.41	.07
Mother to Child	.51	.40	.30
Movement			
Child Total	.24	.39	.17
Towards Mother	.49	.60*	.27
Mother Total	-.46	-.41	-.54*
Towards Child	-.37	-.25	-.40
Touching			
Child Total	-.31	-.24	-.07
Mother Total	-.52	-.43	-.46
Distance	.24	.19	.27

*$p < .05$
**$p < .01$

their mothers more often. Their mothers tend to look more frequently at them (with consequently more eye contact) and tend to touch and move towards their child less frequently. Most of these tendencies are more pronounced when only hearing parents are considered. (POLA scores are not presented in tables for hearing parents because of the small sample size.)

The finding that mothers of more competent children touch and move towards their child less may seem somewhat paradoxical at first, since these behaviors would seem to suggest closer mother-child interaction. Closer inspection of the data suggests the opposite however. Movement towards the child is significantly correlated ($p < .05$) with mothers rated high in use of physical coercion ($r=.39$), poor success in communication ($r=-.46$), and low understanding of the child's needs ($r=-.40$). Similarly, when touching by the mother is broken down into its major functions, to comfort and to get the child's attention, the former is uncorrelated with language competence while the latter is significantly correlated with poor scores on the REEL scale at 24 ($r=-.58$) and 36 ($r=-.55$) months.

In summary, proximal behaviors on the part of the mother (moving towards, touching, and staying close to her child) are associated with poor language competence in the child while the more distal behaviors of looking (and possibly vocalizing and gesturing) are associated with greater competence.

Table 6 presents correlations between selected language behaviors of hearing mothers during the free interaction segment of the OAMIC and measures of the child's language competence. Although there is a tendency for mothers of the more linguistically competent children to talk more, when the number of utterances is controlled, few correlations are significant. The children with better language attend to a greater percentage of their mothers' utterances and follow a greater percentage of their mothers' directions. Use of questions, repetitions, directions, the child's name, and praise seem unrelated to the child's acquisition of language.

Most striking is the consistently high negative correlation between the number of critical or inhibiting utterances and the measures of child language. As can be seen also from Tables 7 and 8, mothers of children with better language were rated lower in use of physical coercion during the OAMIC. They were also rated as more adaptive and successful in getting the child's attention and communicating tasks.

Table 6

Correlations Between Mother's Language Behavior on OAMIC and REEL Scale Language (Hearing Parents Only)

	REEL Scale Language at:		
	24 Mos.	30 Mos.	36 Mos.
Number of Utterances	.51*	.42	.24
Average Length of Utterance	.17	-.06	-.01
[1]Number Child-Related Utterances	.47	.30	.13
% Utterances Attended to	.34	.51*	.42
[1]Number Questions	.37	.31	.03
[1]Number Repetitions	.37	-.32	-.23
[1]Number Directions	.24	-.08	-.45
% Directions Followed	.52*	.49*	.51*
[1]Number Rewarding	.11	.10	.09
[1]Number Critical	-.64*	-.67*	-.58*
[1]Number Child's Name	-.25	.13	.06

*$p < .05$

[1]Partial correlations, number of utterances held constant.

Table 7

Correlations Between OAMIC Behavior Ratings and Child Language at Four Age Levels (All Ss)

	REEL Scale Language at:			
	24 Mos.	30 Mos.	36 Mos.	40 Mos.
MOTHER				
Models behavior	-.25	-.32	-.12	-.44
Uses gestures	-.01	.00	.24	.33
Uses coercion	-.47*	-.36	.14	-.21
Gets attention	.15	.52**	.49*	.24
Communicates task	.47*	.42*	.45*	.22
Adaptiveness	.42	.46*	.45*	.57**
CHILD				
Responds to name	.31	.34	.41	.35
Responds to negative	-.04	-.06	.14	.28
Responds to oral directions	.47*	.48	.30	.16
Gestures to show wants	.24	.12	.18	.16
Vocalizes to show wants	.04	.19	.16	.25
Jabbers expressively	.12	.17	.08	.24
Imitates gestures	.04	-.01	.10	.12
Imitates vocalizations	.27	.38	.21	.22
Cries during separation	.22	-.17	-.02	.04

*$p < .05$
**$p < .01$

Table 8

Correlations Between OAMIC Behavior Ratings and Child Language at Three Age Levels (Hearing Parents Only)

	REEL Scale Language at:		
	24 Mos.	30 Mos.	36 Mos.
MOTHER			
Models behavior	-.19	-.43	-.35
Uses gestures	-.15	-.11	.21
Uses coercion	-.55*	-.60*	-.66**
Gets attention	.16	.60*	.43
Communicates task	.50*	.67**	.68**
Adaptiveness	.37	.57*	.66**
CHILD			
Responds to name	.44	.60*	.64**
Responds to negative	-.19	.03	.47
Responds to oral directions	.56*	.62**	.53*
Gestures to show wants	.13	.20	.24
Vocalizes to show wants	-.07	.32	.13
Jabbers expressively	.30	.66**	.55*
Imitates gestures	-.01	.18	.31
Imitates vocalizations	.14	.50*	.37
Cries during separation	.11	.12	-.02

*$p < .05$
**$p < .01$

The finding that affective components of the mother-infant interaction may be more salient in the child's language acquisition than specific aspects of the mother's language behavior is further supported by data presented in Tables 9 and 10. Mothers of children with high language competence at 3 years of age do tend to be rated higher by the teachers in those aspects of language and affective behavior hypothesized to facilitate language learning; however, the highest correlations are consistently with the affective aspects. Again, the mother's ability to motivate the child without coercion provides one of the best predictors of the child's language competence. Emotional acceptance, ease in relating to the child, encouragement of independence, and sensitivity to the child's needs are all very highly correlated with the child's development of language skills.

Since causal interpretations of correlation coefficients are always fraught with danger, it is necessary to examine some alternate hypotheses. One possible interpretation is that the observed aspects of mother-child interaction are a consequence, rather than an antecedent of the child's language acquisition. This interpretation would suggest that children with poorer receptive and expressive language force the mothers into more proximal modes of communicating and into more coercive and critical modes of relating. Since the child is less responsive to the mother, the mother becomes less accepting and sensitive to the child's needs.

The present data do not permit distinguishing between the hypotheses that maternal warmth is an antecedent or consequent of the child's language competence. In fact, the concept of a mother-child communication system implies a dynamically interactive cause-effect chain rather than a simple one-way system of influence.

More light may be shed on this interaction by examining Table 11, which presents mean differences between early and late admitted Ss on the three sub-scales of the Mother-Infant Communication Rating Scales.

Since the language behavior of the deaf parents was rated with different anchoring points from that of the hearing, the two groups cannot reasonably be compared on this dimension. However, striking differences are again found between the mothers of children admitted before and after 16 months in both language behavior and closeness to the child. This

Table 9

Correlations Between Teacher Ratings of Non-Language Behavior and Child's Language at Four Age Levels (All Ss)

	REEL Scale			POLA
	24 Mos.	30 Mos.	36 Mos.	40 Mos.
B. Mother's Relation to Child	.64**	.45*	.64**	.80**
16. Emotional acceptance of child	.60	.42*	.58**	.75**
17. Realistic about child's potential	.58*	.39	.50*	.72**
18. Ability to motivate without coercion	.37	.20	.61**	.72**
19. Expression of warmth and affection	.67**	.38	.51*	.65**
20. Encourages independence	.53*	.53**	.64**	.71**
21. Amount of interaction with child	.42	.32	.46*	.65**
22. Sensitivity to needs	.53*	.41	.59**	.63**
23. Ease in managing child	.57*	.36	.46*	.75**
24. Creativity in playing with child	.08	.23	.41	.26
25. Ease in relating to child	.70**	.38	.60**	.80**
26. Apparent enjoyment of child	.59**	.34	.46*	.71**
27. Smoothness of communication	.51*	.19	.55**	.61**
C. Mother's Response to Program	-.03	.06	.26	.12
28. Attendance in program	-.02	.03	.07	.03
29. Maintaining hearing aids	-.07	-.02	.06	-.15
30. Home is optimal environment	.15	.46	.28	-.16
31. Understands special needs	.12	.14	.44*	.34
32. Understands development	.24	.21	.47*	.20
33. Cooperates with staff	.05	-.05	.15	.17

*$p < .05$
**$p < .01$

Table 10

Correlations Between Teacher Ratings of Mother's Behavior and Child's Language at Three Age Levels (Hearing Parents Only)

	REEL Scale Language at:		
	24 Mos.	30 Mos.	36 Mos.
A. Mother's Language Behavior	.10	.22	.56*
1. Loudness of voice	.03	.09	.36
2. Variety in pitch and loudness	.14	.19	.52
3. Clarity of speech	.15	.04	.24
4. Rate of speech	.13	-.02	.06
5. Appropriateness of vocabulary	.30	.02	.14
6. Uses optimal sentence length	.58*	.03	.13
7. Elicits language from child	.55	.31	.63
8. Rewards child's verbal efforts	.42	.06	.46
9. Expands child's language	.28	-.07	.09
10. Encourages language imitation	.22	-.05	.25
11. Relates language to child's actions	.13	.10	.30
12. Uses voice to get attention	.22	-.06	.27
13. Uses gestures to explain sounds	.19	.20	.41
14. Makes speech highly visible	.29	-.03	.28
15. Speaks to child often	.29	-.08	.29
B. Mother's Relation to Child	.68	.47	.77**
16. Emotional acceptance of child	.60*	.41	.71**
17. Realistic about child's potential	.57	.37	.58*
18. Ability to motivate without coercion	.41	.29	.84**
19. Expression of warmth and affection	.68*	.34	.54*
20. Encourages independence	.47	.50	.76**
21. Amount of interaction with child	.40	.23	.52
22. Sensitivity to needs	.55	.49	.74**
23. Ease in managing child	.52	.27	.53*
24. Creativity in playing with child	.05	.09	.42
25. Ease in relating to child	.75**	.47	.81**
26. Apparent enjoyment of child	.63*	.44	.62*
27. Smoothness of communication	.51	.14	.64*
C. Mother's Response to Program	-.04	.29	.46
28. Attendance in program	.10	.25	.25
29. Maintaining hearing aids	-.03	.12	.22
30. Home is optimal environment	.31	.82*	.73*
31. Understands special needs	.22	.39	.69**
32. Understands development	.40	.43	.61*
33. Cooperates with staff	.15	.10	.30

*$p < .05$
**$p < .01$

Table 11

Mean Mother-Infant Communication Ratings of Early and Late Admitted Ss

Mother Rating on:	Early Admission		Late Admission	F Ratios		
	Parent Hearing Status			Total	Early vs. Late	Deaf vs. Hearing
	Deaf	Hearing	Hearing			
Language Behavior	52.80	64.44	51.40	4.95*	6.65*	3.25
Relation to Child	51.90	48.89	37.40	7.06**	13.60**	< 1
Response to Program	18.60	20.78	18.40	< 1	1.25	< 1

*p < .05
**p < .01

finding lends support to the hypothesis, considered earlier, that mothers who bring their children in earlier for diagnosis and remediation may be more sensitive, concerned, or have other personality characteristics which facilitate language acquisition. Although it may also be argued that the higher ratings may reflect positive changes associated with greater length of time in the program, this alternative seems unlikely. All Ss had been in the Infant Center program for at least 12 months at the time the ratings were made, sufficient time for specific program effects on the parents to be established as well as sufficient time for the traumatic effects of handicap discovery to be mitigated. Also, as can be seen from the table, specific aspects of response to the program such as attendance, cooperation, or hearing aid maintenance do not discriminate among the groups.

An alternate approach to the same data is to inspect the correlation coefficients between age of child at time of admission, mother relationship rating, and child language competence. When the child's age at admission is partialed out of the correlation between subscale rating for mother relationship and language score, the r falls only from .64 to .62 for the 3-year-old REEL Scale and from .80 to .78 for the POLA. Both correlations are large and highly significant. In brief, among infants admitted to the Infant Center before

their second birthday, the ease, warmth, and closeness of mother-infant communication appear to be the major influences on the child's language development.

CHAPTER IV

DISCUSSION

The results clearly indicate that, whatever the network of cause-effect relationships, there are identifiable aspects of mother-infant interaction which are intimately associated with the rate of language acquisition of the hearing-impaired child. Strikingly high correlations appear throughout a wide range of such interactions in spite of the limitations of method and small sample size.

A review of the literature of mother-child interaction will convincingly demonstrate that reciprocal rather than simple one-way influence is the norm. From the moment of birth, and perhaps before, mother, child and environment mutually affect each other in a complex chain difficult to unravel.

Recently, Clarke-Stewart (1973) attempted to unravel aspects of this causal chain by means of cross-lagged panel correlation techniques (Campbell, 1963). She found that the amount of maternal attention and looking influenced the child's later performance on an intelligence test and that the child's activity and exploration was also negatively affected by maternal restrictiveness. In addition, she found that:

> ... the process of reciprocal mother-child influence was clearly demonstrated. The more often the child looked, smiled or vocalized to his mother, the more affectionate and attached to the child she became and the more responsive she was to his distress and demands. That this causal direction is maintained throughout infancy and childhood cannot be asserted. In fact, the possibility of causal "role reversal" throughout the course of development was suggested by the study (p. 93).

In the present study, at least three reciprocally influencing systems are present: (1) characteristics associated with the mother, such as her concern for the child, language, warmth, and nurturance, sensitivity, acceptance, etc.; (2) characteristics of the child, such as his/her residual hearing and language, responsiveness to the mother; temperament, etc.; (3) characteristics of an early intervention

program, including hearing aids, auditory training, emotional support and counseling; etc.

It is possible to view the mutually interactive effects of these systems upon each other in a variety of ways. It has been suggested by the data, for example, that the hearing mother's sensitivity to and degree of involvement with the child may be a selective factor which leads to early diagnosis and referral of the child to an intervention program such as Lexington's Infant Center.

Maternal warmth and sensitivity possibly facilitates and is reinforced by the child's attentiveness and responsiveness to the mother. Possibly, this reciprocally interactive system is further supported by the auditory training for the child and education and counseling given to the mother, which might otherwise by ineffective.

Clinical experience at the Infant Center suggests that the hearing mother's discovery that her child is deaf has traumatic effects, producing conflicting feelings of rejection, guilt, and overprotection. These disrupt the normal flow of verbal and nonverbal communication with the child. An increase in critical and coercive behavior by mothers of deaf children has been noted by other researchers as well as by clinicians.

Goss (1970) found that when compared to mothers of hearing children, mothers of deaf children were less likely to use verbal praise or to use language showing solidarity and agreement and were more likely to show verbal antagonism, disagreement and tension. He attributes these differences to "the desire of the mother to communicate and the nature of the child's disability which makes communication difficult and frustrating" (p. 96).

In the present study, the number of critical, inhibitory utterances by the mother and her use of coercive motivational techniques were highly correlated with low rate of language acquisition in the child.

In one of the few studies of mother-infant interaction with hearing-impaired children, Altman (1973) found that hearing mothers of 4-to 7-year-olds rated as linguistically competent are more actively involved in their child's language

development, generate more verbal interaction, monitor their child's behavior with more feedback, place more pressure on their child to perform, use more positive reinforcers, manifest more warmth and positive affect, use less negative reinforcers, and are more child-centered than mothers of linguistically less competent children.

The present study supports many of these earlier findings. The linguistic superiority of deaf children of deaf parents indicated in earlier studies (Vernon & Koh, 1970, 1971) may be largely due to the less traumatic effects of the discovery of the child's handicap on the deaf mother. In the present study, deaf mothers were rated as warmer and the flow of communication between mother and child as easier. The children from deaf families tended to do better in ratings and tests of language competence, but the children of hearing parents rated as warmer and more sensitive to their child tended to do as well. The data suggest that the nature of the mother-infant interaction is more crucial than the mother's hearing status.

Since teacher ratings of aspects of mother-infant interaction may be influenced by halo effects and other biasing factors, much emphasis has been placed in this study on direct observation and objective analysis of spontaneous interaction in the OAMIC situation. The direction of the correlations were for the mothers of the linguistically better children to look, vocalize, and gesture more and to touch, move towards, and stay close to the child less. In the case of looking, moving, and touching, these correlations were statistically significant. The children tended to move towards their mothers more and to look at them more.

Lewis and Ban (1971) suggest that mother-infant attachment may be viewed in terms of two distinct behavior clusters: proximal (touching and staying close to) and distal (looking, vocalizing, and gesturing). They point out that an aim of socialization is to move the child from proximal to distal modes and that, in fact, touching decreases with age while looking increases. In studying changes in these modes of attachment from one to two years of age, Lewis, Weinraub, & Ban (1972) suggest that while proximal behavior may be a valid index of attachment for one-year-old children, it may suggest insecure attachment in two-year-olds.

In view of these findings, the linguistically competent mother-child dyads may be viewed as manifesting more secure and developmentally mature modes of interaction. In the present study, the amount of mutual visual regard or vis-à-vis eye contact was the one variable most closely associated with language acquisition.

In reviewing the role of eye contact in mother-infant attachment, Robson (1967) considers this single variable as "probably the most sensitive indicator of how two objects 'feel about' one another (and often how they feel about themselves)."

Moss and Robson (1968) found that the extent to which a pregnant mother viewed her future baby as gratifying, pleasant, and nonburdensome and the amount of interest she exhibited toward the prospect of holding and cuddling her infant served as predictors of mutual visual regard (eye contact) when the child was one month of age.

Children of deaf parents maintained sigificantly more eye contact than those of the hearing, and children of hearing parents rated as interactionally closer and warmer also maintained more eye contact.

For the hearing-impaired child, eye contact with the mother is not only an index of closeness of the mother-child bond, it is also a major avenue through which language is acquired. Until such time as the hearing-impaired child's residual hearing can be sufficiently mobilized by aids and training, vision is the chief mode of getting and maintaining attention and of communicating with the child.

Although no sample of hearing children was tested in the current study, the investigators were struck by the relatively low amount of looking at the mother evidenced by the linguistically less competent deaf children. In part, this was influenced by the situation. The mother and child were led into a playroom with a large number of attractive toys, and most children immediately went to the toy shelves. Looking at the mother is negatively correlated, in the present study, with the mother's use of physical coercion to motivate the child and positively correlated with ease in relating to the child, emotional acceptance, and expression of warmth and affection. It may be that the child who is conditioned to expect criticism, restraint, and disapproval from the mother

"tunes out" the mother in the play situation by averting his gaze and thereby avoiding the expected "don't."

Educational Implications

Perhaps the most important finding of this investigation is the centrality of the affective aspects of mother-infant interaction to the language acquisition of the hearing-impaired child. Specific aspects of the mother's language programming of the child, however useful, pale in significance when compared to the importance of restituting the damage done to the mother-infant bond by her discovery of the child's handicap. Clearly, deaf parents whose oral skills are limited can still raise children relatively superior in language competence to those of hearing parents in whom this bond is disrupted. Quite possibly the mother's capacity to accept the reality of the child's handicap is itself a factor influencing early diagnosis.

The failure of our current medical services system to provide early diagnosis and referral of hearing-impaired infants approaches the proportions of a national disgrace. The mean age of referral for 28 deaf children of hearing parents, admitted to the Lexington Infant Center over the past three years, is 19 months. Conversations with parents whose children were diagnosed relatively early reveal recurrent instances in which the mother had to bring her child to several prediatricians before she would find one who would not put her off. Often, this appeared due to the medical practitioner's lack of awareness of modern audiological practices and the availability of early intervention programs. Clearly, a major responsibility of such programs is to educate the medical establishment.

The Lexington School for the Deaf Infant Center has already begun to shift its chief thrust from tutoring infants to the provision of a broad range of educational and mental health services to parents. The reciprocally augmenting cycle of parental frustration and negative child reaction may be attacked at several levels. The main priority must be given to helping the mother adjust to her child's handicap and to facilitating the flow of communication between them. Any progress made by the child will reward the mother and aid this process, but insofar as the anxious mother feels impelled to coerce her child, the process will be impeded.

Teachers or audiologists who provide services to hearing-impaired infants should be given training in emotional counseling.

Suggestions for Future Research

A number of questions posed by this investigation still require answers. The question of when or whether there is a critical period for early intervention remains unanswered. The present study did not evaluate the language competencies of children provided with amplification and training after two years of age, and its sample of those from hearing homes admitted during the first year of life was too small for analysis. In addition to continuing to collect data on such children, it would be useful to follow-up the Infant Center children for several more years to see if the reported differences diminish.

While it is doubtful that any research approach will be able to completely unravel the interactions between mother, child, and environmental variables affecting the deaf child's language acquisition, the investigation just completed can be regarded as a beginning step. Some of the procedures developed for investigating this interaction and measuring language seem highly promising. Perhaps future research in this area will further refine this crude ore.

PART II

NEW DEVICES FOR AUDITORY TRAINING

CHAPTER V

INTRODUCTION

Basis for the Project

The purpose of this part of the project was to develop devices which might facilitate receptive and expressive language development in the hearing-impaired preschool child. A review of the literature of auditory training devices for the hearing-impaired shows a variety of aids which can be used by school-age children. In addition to hearing aids which provide direct compensation for hearing losses through amplification of the auditory signal, there are a variety of devices which transform this signal into another sense modality or, by means of a meter, monitor some feature of the acoustical stimulus such as pitch or amplitude.

Preschool children (birth to 3 years) have been fitted with hearing aids in response to the growing evidence of investigators (Elliot & Armbruster, 1967; Ewing, 1962; Fry, 1966; Quigley, 1966) that children with moderate and severe hearing losses may gain an advantage in language acquisition if they are fitted with hearing aids at the earliest possible age. Auditory transformation devices, however, have by and large been designed for children older than three years. To mention a few, such devices as the LUCIA, s-indicator, fricative indicator, frequency transposer, tactile vocoder, and visible speech translator are too complex for the preschool child to learn and use.

It is well-known that the rate of spontaneous vocalization and babbling of deaf infants falls off rapidly after the sixth month of life (Lenneberg, Rebelsky, & Nichols, 1965; Mavilya, 1969), presumably due to lack of reinforcement. Although Lenneberg is of the opinion that early vocalization is under maturational rather than social control, there are numerous studies demonstrating that both the quantity (Ramey & Ourth, 1971; Rheingold, Gewirtz, & Ross, 1959; Sheppard, 1969; Weisberg, 1963) and quality (Routh, 1969) of vocal output by infants can be affected by operant conditioning procedures. It appears that while social reinforcement is not essential, conditioning is more effective when such reinforcers have been used (Haugan & McIntire, 1972; Rheingold, Gewirtz, & Ross, 1959; Todd & Palmer, 1968; Weisberg (1963). Additionally Ramey & Heiger (1972), in a review of the literature on contingent reinforcers, report that contingent vocal reinforcers are more successful in production and shaping of vocalizations than

either non-contingent or intermittent reinforcement.

In view of these findings, it might be hypothesized that reinforcing the vocalizations of deaf infants would accelerate speech acquisition. Such a hypothesis should be advanced only with great caution. While numerous studies have demonstrated that both rate and the phonemic characteristics of vocalizations may be modified in hearing infants, no such findings have been demonstrated with the hearing-impaired. Furthermore, though some researchers (Karelitz, Fisichelli, Costa, Karelitz, & Rosenfield, 1964; Cameron, Livson, & Bayley, 1967; and Spiker & Irwin, 1949) have related early vocal production to later intellectual development with mixed results, it has not been demonstrated that the frequency of infant babbling is related to later speech or language acquisition. In addition, although the development of devices which provide immediate visual or tactile reinforcement contingent upon vocalization is clearly warranted for hearing-impaired infants, there is no guarantee as to their effectiveness. Social reinforcement by a parent, for example, may be far more efficacious than any automatic device.

Plan of Development

While language curriculum and auditory training procedures designed for home use have already been developed for hearing parents of deaf preschool children (Harris, 1971; John Tracy Clinic, 1968; Northcott, 1970; Pollack, 1970), the sizeable population of deaf children whose parents are deaf has been neglected. Yet it would seem to be just this population which stands most in need of training devices. Lenneberg, Rebelsky, & Nichols (1965) point out that:

> The acoustic stimuli surrounding the child of deaf parents differ in quality and quantity from those surrounding the hearing parents' child. The voice of a deaf mother has, invariably, a strained quality and an abnormal pitch. Intonation patterns are dramatically different from those heard in average English .....
>
> Another qualitative difference is due to the deaf parents' difficulty in guessing whether the child's facial expressions and bodily movements are or

are not accompanied by vocalizations such as crying or cooing (pp. 27-28).

Since the deaf mother would appear to be at considerable disadvantage in perceiving and subsequently reinforcing her infant's vocal productions, sound-activated devices which provide immediate contingent visual reinforcement for such productions should be at their most valuable. In addition, deaf parents typically present their child with an auditory environment characterized by limited language production and poor speech articulation. Receptive language devices which provide useful and clearly articulated language could be of considerable importance to the aided preschool child residing in a deaf home.

Given these considerations, the plan of development for this part of the project was to develop a sound-activated vocal-reinforcement device which would be attractive to infants, along with a flexible procedure for programming oral language into the deaf home. The former would produce a visual stimulus contingent upon a vocal response, and the latter an aural language stimulus contingent upon some other response.

Given the limited staff and resources of the project, only pilot research could be conducted towards testing the utility of prototypes of such devices, ascertaining the problems involved, and evaluating the relative efficacy of social and automatic device reinforcement procedures.

CHAPTER VI

APPARATUS AND PILOT RESEARCH

Sound-Activated Devices

The Mobile

The initial device selected for study was a sound-activated mobile. Development of this device proved to be far more time-consuming and problematic than anticipated. The first problem was that of design. As might be expected in any hardware development project, early prototypes of this device suffered from numerous inadequacies of a mechanical or electrical nature. The battery power supply of the initial model was variable and required frequent changes. The wiring was too delicate to sustain normal handling and frequently was damaged. The mobile, a rag doll, responded slowly to cessation of vocalization and, depending upon momentum built up by the vocalization, often remained spinning for 3 to 6 seconds. A second major problem was that of sensitivity. If set at too sensitive a level, the vocal relay would be activated by all environmental sounds and not only by the infant's vocalizations. If set at too high a level, the mobile would not respond to many soft vocalizations at all. Infants vary in the acoustic energy of their vocalizations, requiring careful adjustment for each infant. If placed too distant from the infant, the microphone would not pick up soft vocalizations but would pick up environmental sounds. If placed too close to the infant, the microphone would become a visual distraction or would even be played with by the infant. In addition, early models were intended for crib mounting and thus were limited in their use to infants under nine months of age when lying on their back in the crib. Efforts to test early models of the mobile on hearing-impaired infants in the program led to incomplete or inconclusive data because of these defects. As the mechanical problems were solved, the infants became too old for the crib mobile.

Following several months of modification, a voice-activated mobile was constructed which was mechanically more reliable than previous models and sufficiently versatile to be used with older infants. This device is mounted on a tripod with a stable base. Its height is adjustable and the unit runs on household current, assuring a more reliable energy supply. It can be used with infants who are sitting as well as prone. The wiring is connected to removable plugs which, in turn,

are connected to a control box, minimizing damage done by handling. The mobile action is controlled by solenoids which instantly start and stop the mobile upon the onset and cessation of vocalization. The unit contains an easily adjustable microphone position and relay sensitivity control. It can be activated automatically by acoustic energy or manually, so that selective reinforcement is possible. This permits potential shaping of vocalizations as well as the capability of avoiding mobile activation by environmental sounds. An output to a tape-recorder permits recording of all vocalizations for later analysis. A schematic diagram of this device is appended to this report.

After problems of design were ironed out, the mobile was tested in an experiment to evaluate the effectiveness of four vocal reinforcement conditions on infant vocalization rate. The experiment was designed to test the relative effectiveness of contingent vs. non-contingent reinforcement using social and non-social reinforcers.

During the contingent social reinforcement condition, the infant was reinforced for each vocalization by E's smiling, touching, and talking to the infant. During the non-contingent social reinforcement condition, the same reinforcement procedure was carried out four times per minute regardless of the infant's vocalizations. During the contingent non-social condition, the mobile was activated whenever the infant vocalized. During the non-contingent non-social reinforcement condition, it was activated four times per minute by E regardless of the infant's vocalizations.

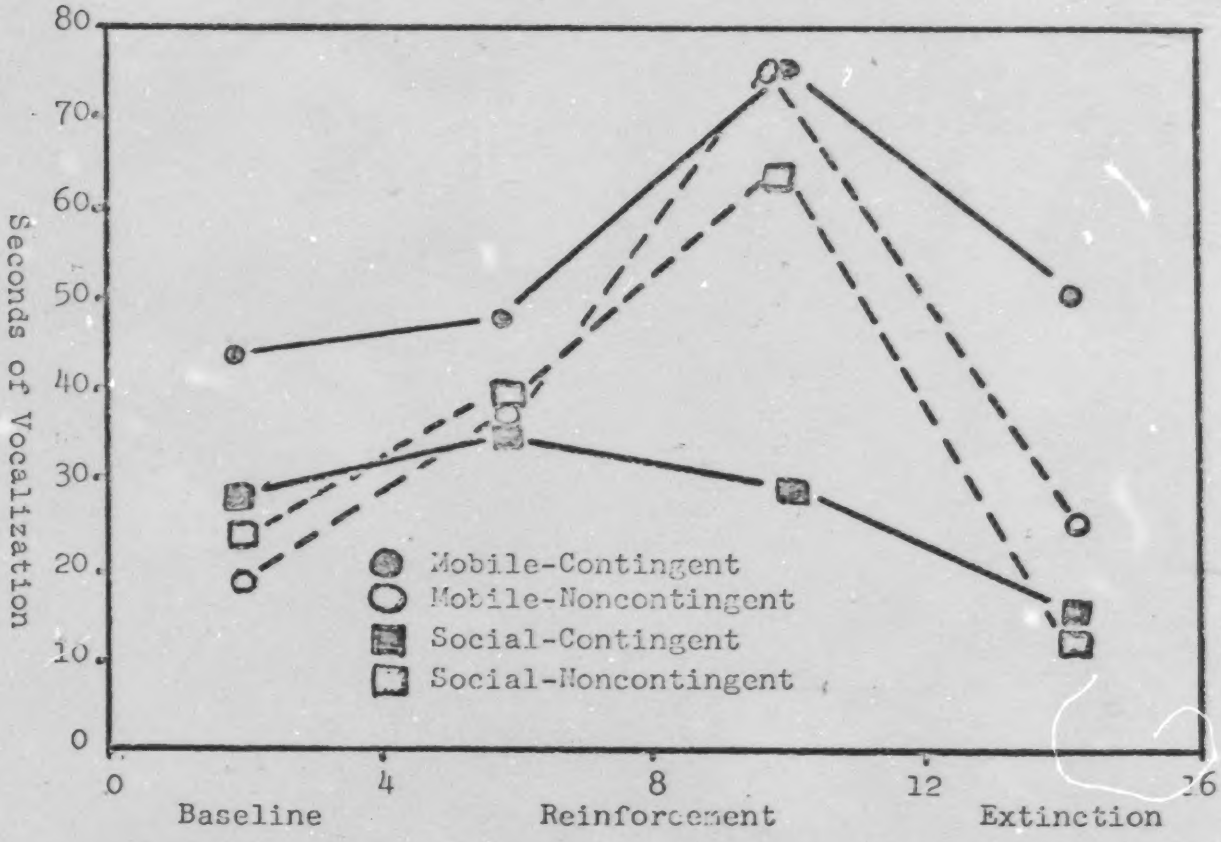
The first 5 minutes of each 20-minute session was devoted to collecting baseline vocalization data. This was followed by 10 minutes of conditioning and 5 minutes of extinction. Each of the four conditions was administered on four occasions (once each day and balanced for morning and afternoon sessions by the Latin Square method).

Pilot data were collected, using this procedure, on a 7-month-old hearing infant who was studied over 16 experimental sessions (4 replications of each of the 4 conditions: contingent-social, contingent-mobile, noncontingent-social, noncontingent-mobile). Duration of infant vocalizations were recorded during four-minute reinforcement, and four-minute extinction periods.

Average vocalization rate during each four-minute period is presented below in Figure 1.

Figure 1

Vocalization Rate of 7-Month Old Infant
to Mobile and Social Reinforcement
Under Contingent and Noncontingent Conditions



As can be seen, there was a rise in vocalization rate from baseline to reinforcement periods and a decline during extinction in all four experimental conditions. An analysis of variance was performed contrasting the 8-minute reinforcement period with the 8-minute nonreinforcement periods (baseline and extinction). The difference was found to be significant ($F=9.13$, $p < .05$), but the lack of significant interactions between periods and conditions indicated that the increase in vocalization during reinforcement was not dependent upon the contingency or type of reinforcer.

An analysis of variance of the reinforcement periods alone failed to detect a significant difference in efficacy between social and nonsocial or contingent and noncontingent conditions. An analysis of covariance, adjusting for baseline vocalization differences, even further attenuated the small differences noted.

In summary, the statistical analyses (see Tables 12 to 16) confirmed that the introduction and withdrawal of a reinforcer significantly increased and decreased vocalization rate in the infant studied. This trend held regardless of whether the reinforcer was a mobile or a smiling experimenter. However, it also held whether or not the reinforcer was made contingent upon the infant's vocalizations or administered on a fixed interval schedule.

These results may be explained in several ways. Perhaps the most parsimonious explanation is that the change in the total stimulus situation brought about by the introduction of a new element (the mobile or the experimenter) has an eliciting effect on vocalization rate, perhaps as a component of increased arousal. This interpretation would suggest that no conditioning occurred. Another interpretation is that the increase during contingent reinforcement was due to conditioning, but that other eliciting factors taking place during the noncontingent reinforcement sessions may have masked the conditioning effect. For example, since reinforcers were administered at a rate of four per minute during the noncontingent sessions, more reinforcers were actually administered during these sessions than during the contingency periods. Also, since the reinforcers were administered on a fixed interval schedule regardless of infant vocalization, intermittent reinforcement of vocalization may have taken place. Thus, the combination of partial contingent reinforcement and the eliciting effects of more frequent reinforcement may have compensated for the increase noted in the contingency conditions.

Table 12

Mean Vocalization Duration Rates (in Seconds) for Each Phase of Each Condition

	Baseline	Reinforcement I	Reinforcement II	Extinction
Social Contingent	28.50	34.00	29.00	17.00
Social Noncontingent	24.25	39.50	62.25	13.75
Nonsocial Contingent	43.50	47.75	73.75	50.75
Nonsocial Noncontingent	19.00	35.75	74.00	26.75

Table 13

ANOVA Summary Table of Overall Vocalization Rates

	df	MS	F
A Social vs. Nonsocial	1	3797.64	6.94*
B Contingent vs. Noncontingent	1	206.64	< 1
C Reinforcement vs. Nonreinforcement	3	3616.31	6.61**
AxB	1	2104.52	3.85
AxC	3	599.56	1.10
BxC	3	837.81	1.53
AxBxC	3	47.26	< 1
Error	48	547.16	

*$p < .05$
**$p < .01$

Table 14

ANOVA Summary Table: Reinforcement vs. Nonreinforcement

		df	MS	F
C	Reinforcement vs. Nonreinforcement	1	7460.64	9.13*
AxC	Social vs. Nonsocial	1	23.76	<1
BxC	Contingent vs. Noncontingent	1	1395.64	1.71
AxBxC	Interaction	1	337.65	<1
Error		12	816.92	

*$p < .05$

Table 15

ANOVA Summary Table: Vocalization Rates During Reinforcement Periods Only

		df	MS	F
A	Social vs. Nonsocial	1	4422.25	2.26
B	Contingent vs. Noncontingent	1	729.00	<1
AxB		1	2550.25	1.30
Error		12	1960.38	

Table 16

Analysis of Covariance: Vocalization Rates During Reinforcement Periods Adjusted for Baseline Vocalization Rates

	df	MS	F
A Social vs. Nonsocial	1	3203.61	1.75
B Contingent vs. Noncontingent	1	.01	<1
AxB	1	889.99	<1
Error	11	20114.63	

An experiment was planned to determine which of these hypotheses is more acceptable by equalizing the amount of reinforcement in the two periods. Unfortunately, two efforts to perform this experiment on 7-month-old infants, one hearing and one deaf, failed to establish conditioning and led to the abandonment of the mobile as a promising vocalization reinforcement device for deaf infants.

Reasons for this abandonment were as follows:

(1) The mobile, while initially eye-catching, failed to provide a consistently interesting visual display for the majority of children studied, in spite of frequent substitution of the objects attached;

(2) the mobile is by its very nature stationary while the infant is becoming increasingly more mobile, and it provides no manipulanda for the infant's increasing need to operate physically on his environment;

(3) since a stationary microphone will respond to any acoustic stimulus of sufficient energy, normal sounds of the home environment tend to activate the device. The alternatives of lowering the sensitivity of the microphone or instituting a silent environment both are unacceptable and defeat the purpose of the device;

(4) any motor-driven device produces noise, creating a feedback problem, as well as inertial forces which make immediate reinforcement contingent upon onset and cessation of vocalization difficult.

Essentially then, the goal of developing this general type of device into a simple, inexpensive vocal reinforcement procedure for home use was not achieved and would appear to be unattainable.

The Deci-Bear

Experience with the mobile led to a reconsideration of the specifications for a vocal reinforcement device for deaf infants. To circumvent problems encountered in the mobile research, the device would have to be: (1) intrinsically interesting to the majority of children in the age group; (2) portable and manipulable by the child; (3) safe and sturdy; (4) sensitive enough to be activated by the child without

requiring artificial muting of environmental sounds; and (5) free of feedback problems.

The device designed to meet these considerations was "Dessy," the Deci-Bear. Essentially this battery-operated device is a stuffed Teddy bear whose eyes light up and blink in response to low level acoustic input and whose nose lights and blinks in response to higher acoustic levels. The original eyes and nose of the bear have been replaced by a red light (for the nose) and two yellow lights (for the eyes) which cannot be broken by the child. The difference in sensitivity level between the eyes and nose lights, as well as the overall sensitivity level of the system, may be adjusted by an internal control.

The electronic circuit, in a small box, is buried within the body of the bear and surrounded by foam padding. This protects the device, renders it relatively insensitive to vibration or rough handling, and keeps it from the child. It may nevertheless be readily removed by an adult. An on-off switch is located just within the bear's armpit where it may be operated by an adult but is unseen by the child. A schematic diagram of the Deci-Bear circuitry is appended to this report.

The Teddy bear is small (12 inches in length), light enough to be carried about by a young child, and may easily be placed in an infant's crib. Since Teddy bears, even without blinking eyes, are favorite toys of infants and toddlers, it was hoped that "Dessy" would provide the intrinsic interest which the mobile lacked. Since the child could hold it close to the face, it could respond to the child's vocalizations at a sensitivity level low enough to keep it from being activated by all except very loud environmental sounds. Also, the transduction of acoustic to electrical, rather than mechanical, energy eliminated the inertia and feedback problems of the mobile.

Initial pilot research at the Infant Center was directed at determining (1) if the Deci-Bear was effective in increasing vocalizations; (2) if it was sufficiently interesting to be preferred over other toys; (3) with what age group it is most effective; and (4) whether it could sustain the child's interest over a relatively prolonged period of time.

The first study to determine effectiveness was conducted with a 12-month-old profoundly deaf child of deaf parents. In

the first test session, conducted at the Infant Center, vocalizations were recorded during (1) a baseline period of 10 minutes during which the bear was de-activated but the child could play with it; (2) a training period of 5 minutes during which the bear was activated and demonstrated to the child; (3) a testing period of 10 minutes during which the bear could be activated by the child; and (4) an extinction period of 10 minutes during which the bear was again de-activated.

The child vocalized 21 times during baseline, 38 times during training, and continuously for 98 seconds during extinction, after which she pushed the bear away.

Following this initially promising result, a preference study was designed to test interest in "Dessy" compared to other toys. The procedure consisted of three 5-minute testing periods with mother and teacher present in the room. During each period, E showed the child three toys: a fuzzy stuffed elephant; a Raggedy Ann doll; and "Dessy." The E vocalized to each toy, pointing to eyes and nose and demonstrating the contingency of vocalization and visual display. All three toys were then left in the room while E observed the child through an observation window. Number of vocalizations and spontaneous pick-up of each toy was recorded for each of three sessions with 15 deaf children ranging in age from one to three years.

Table 17

Number and Percent of Children Spontaneously Picking Up or Vocalizing to Deci-Bear (D) and Other (O) Toy

		Session							
		1		2		3		Total	
		D	O	D	O	D	O	D	O
Spontaneous Pick-up	N	9	3	10	2	11	2	30	7
	%	60	20	67	13	73	13	67	16
Vocalization	N	7	1	7	0	9	1	23	2
	%	47	7	47	0	60	7	51	4
Mean Number of Vocalizations		10.27	.07	6.93	0	9.60	.13	26.8	.20

Even with so small a sample, it is apparent that the Deci-Bear does evoke significantly more interest than similar stuffed toys and that deaf children in this age group can learn the contingent relation between vocalization and visual display relatively quickly.

It is not clear that children in this age bracket find the Deci-Bear sufficiently interesting over a period of time to warrant its use as anything other than a novel distraction. In fact, the increasing percentages from sessions 1 to 3 for spontaneous pick-up and vocalization may merely reflect the child's initial wariness or individual differences in learning. Of the 7 children who vocalized to the bear during the first test session, 6 showed fewer vocalizations during subsequent sessions.

In order to test the device under more natural conditions over a prolonged period of time, a formal conditioning experiment was set up in the home of a 7-month-old profoundly deaf girl of hearing parents. The child was in a playpen with "Dessy" outside on a chair within view and reach. Only the mother was in the room with the child and no effort was made to train or demonstrate the toy to the child. For 15 minutes each day, for a 20-day period, the mother, following E's instructions, counted vocalizations. Reinforcement and extinction periods were alternated every four days.

Figure 2 presents a graph of the child's vocalizations to "Dessy" for 19 of the 20 days (data for day 16 is missing because the child was away from home on that day). As can be seen, the child vocalized to the bear more often during reinforcement than extinction periods and the graph has the characteristic shape of operant learning: decreasing responses during extinction followed by spontaneous recovery with the onset of reinforcement. The mean number of responses during reinforcement (101) is nearly twice as great as during extinction (53).

Of equal interest is the finding that even after two weeks of 15-minute per day exposure, the vocalization rate continues to increase. This indicates that, at least for some infants, the toy can sustain prolonged interest and may be of value in reinforcing vocal response.

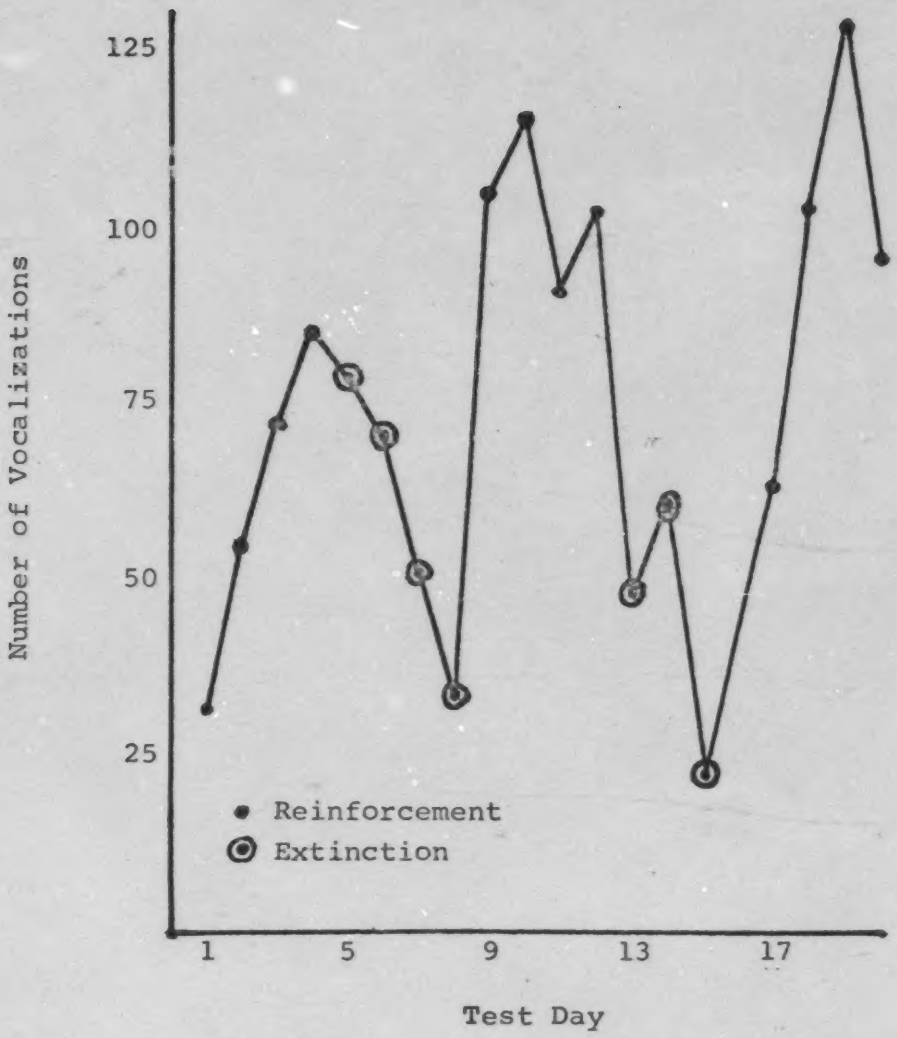


Figure 2 - Vocalizations of a 7-month-old Deaf Child to the Deci-Bear.

The Language Playboard

In an effort to develop a flexible, easily programmable device for providing receptive language stimulation for deaf children, a device called the "language playboard" was developed.

The language playboard has two parts: a tape player and a lever box. The tape player is a Granada 8-track stereo tape recorder/player, Model KHS-825M, which was adjusted to allow for lever control over stimulus presentation (see Appendix). The cartridge tape loops which provide auditory feedback were shortened to the length of the particular language stimulus to be presented. The other part of the language playboard is a 21" x 8" x 6" plexiglass and pressboard rectangular box with four horizontal levers to which different toys can be attached (see Appendix for electronic design). These levers, protruding from the playboard are hollow plastic tubes. Cylindrical plastic rods with their attached toys at one end are inserted into the lever tubes with the other end. The rods with the toys are removed by pulling. This attachment procedure facilitates easy exchange of one toy set for another by a teacher or parent. Additionally it allows for the possibility of adult-child games, or manipulatory games which the child can play alone with the playboard. When a lever is pressed, the auditory stimulus is presented through two 4-inch speakers in the box located between levers 1 and 2, and levers 3 and 4. The lever box is attached to the tape player by means of a long insulated extension cord for convenient location in the home. The device runs on ordinary house current.

Rationale for the Playboard

The language playboard was originally designed for use with the 2- to 3-year-old hearing-impaired child. While other devices such as the Language Master or Audio Flashcard Reader have been used as auditory training devices with this age group, the length of the auditory presentation is limited to a few seconds, and the child s involvement consists essentially of pushing a button and viewing a flashcard. Because the attention span of the 2- and 3-year-old is relatively short, it was hoped that the greater tactile-kinesthetic effect of touching, removing and attaching the toys to the appropriate levers on the language playboard would maintain the preschool child's attention for a longer period. Additionally, investigations suggest that three-dimensional representation is superior to

two-dimensional representation. Sigel (1971), using a sorting task of familiar objects with lower- and middle-class children found that lower-class children have greater difficulty making groups with pictures than with objects. Similarly, a group of preschool disadvantaged children administered the Motor Encoding Test of the Illinois Test of Psycholinguistic Abilities were found to have less difficulty in acting-out, in gestures, the function of an object when the object was presented three-dimensionally rather than as a picture.

The disadvantage of pictures over objects is not unique to the lower-class child. Sigel (1971) reports on memory investigations with 7-year-old middle-class children done by Jackson at Merrill-Palmer Institute which found better recall with three-dimensional than two-dimensional stimuli. Additionally, memory and learning studies with adults comparing relative representational retention difficulty, indicate that objects are more frequently recalled or learned than words.

Pilot Research

The initial questions examined with this device were (1) what kinds of auditory stimuli should be presented and for how long?, and (2) what objects should be selected to accompany the auditory feedback? It was decided to begin with simple nouns and short, useful sentences. Since Ss tended to have better hearing at low frequencies, tapes used a male voice with emphasized bass. The initially constructed tapes of 15 seconds with three repetitions of the message were found to be too long to maintain children's attention. Two types of message were selected: (1) single noun presentation with one repetition(of 5 seconds)and (2) brief sentence presentation with no repetition(of under 10 seconds). Nouns used were familiar persons and objects found in the school or home. For example, a family set consisted of a mommy, daddy, boy, and girl doll which could be easily attached to the levers and a 5-second tape loop giving the words "mommy," "daddy," "boy," or "girl," each repeated once, when the child activated the lever by touching the appropriate doll. Other simple objects demonstrated simple language. For example, a small milk carton attached to a lever produced, when touched, the message, "More milk please" and a toy telephone was used with the message "Hello. Who is this?" Other sets included common household furniture, animals (with their names and sounds), and parts of the face (eyes, ears, nose, and mouth).

Unfortunately pilot research with this device was disappointing when it was applied to the age group for which it was intended. The first attempt consisted of five 15-minute sessions with a 2½-year-old boy, using the sets described above. The E was familiar to the child having previously played with this young boy on three previous occasions. According to the mother, the vocabulary of the toy items used were known to the child, and they were selected because it was hypothesized that familiar words would be more reinforcing than non-familiar words. The child watched with interest as the E demonstrated the toy, but no spontaneous vocalizations or imitations were elicited. The mother stayed in the room during the sessions, and although several experimental procedures were tried to determine if the child was listening, none proved successful in getting any response other than sustained attention. This child was retested at age 3, using photographs of him, his parents, and his dog in an informal 45-minute session. The mother and E played with the child and attempted to interest him in the playboard. Though the child pressed the levers, pointed to the mother and her photograph and to himself and his picture, there seemed to be no attempt to listen to the auditory feedback. The child seemed much more interested in playing with the other toys (ball, plane, baby doll) and his mother than in playing with the language playboard.

A 2-year 4-month old deaf boy of hearing parents was tested in two 15-minute sessions with the language playboard. The purpose of the device was explained to the mother and she was instructed to direct her child's attention to the playboard. In the first session using the eye, ear, nose and mouth tape cartridge, the child showed no interest in the device. In the second session, using animals and animal noises, he spontaneously imitated the sounds he heard, tried to attach the toys to the levers, pressed the levers, and pointed to his ear, indicating that he had heard the auditory message accompanying the lever. However, a 1½-year-old boy, in two similar sessions, showed no interest whatsoever in the playboard.

At this point, it was decided to restrict further testing with this device to older children (3 to 4 years of age) in a nursery classroom to determine its value for this population.

Initially, the children were given the opportunity to play with the playboard without any intervention by E. They pressed the levers one after another, but did not appear to attend to the auditory messages. It became apparent, at this point, that the playboard could only be useful if accompanied by an initial training period.

Several training methods were then instituted to determine their value in encouraging use of the playboard. The most successful of these consisted of removing the toys from the playboard and placing them in front of the child. The lever associated with one of the toys is pressed and the child is asked to listen to the auditory message and to choose the correct toy named from the four presented. A correct response is praised while an incorrect response leads to repetition of the task.

Three 3½-year-old Lexington nursery children were given three half-hour sessions using the above procedure. Following this, an effort was made to see how well this method could be used to teach new auditory language to the children. Toy-cartridge sets were chosen which the child could not correctly identify on the first trial. The children were then trained using the procedure described. At the end of each of three 15-minute training sessions the children were tested to see if they could associate the auditory message with the correct toy. All children were able to learn to discriminate between at least two items in each session. After six sessions with a teacher, all three children understood how the playboard worked and could attend to the auditory message.

Next, an experiment was performed to see whether the trained children would spontaneously choose to play with the playboard. Each child was led individually into a playroom in which were set up: the playboard, a colored ball, an airplane, and a baby doll with pajamas and bedding. E went through the usual playboard testing procedure for a few minutes with the child, placed a new set of toy attachments on the floor, and sat in a chair. In two sessions with each of the three children, none of them spontaneously attended to the playboard after E sat down.

After five minutes, if the child spontaneously picked up a toy attachment, E began to present contingent reinforcement (smiling and nodding "yes" for correct and shaking head with "no") for correct or incorrect attachment of the toy to the levers. If all four were correctly placed, a new tape-toy set was presented and the procedure continued. Under these conditions, all three children played and were able to sustain attention to the playboard for a 10-minute period.

After this 10-minute phase, E left the room for five minutes. None of the children spontaneously played with the

toys or levers during E's absence.

This study, in effect, demonstrated that while the language playboard may be effectively used as a tutoring aid in the classroom, it is not effective as a self-teaching device for the hearing-impaired child.

Auditory-Vocal Training of Deaf Parents

The failure to develop a suitable receptive language device which could be used without direct tutoring by deaf children of deaf parents led to a re-evaluation of the original aims of this part of the project. The purpose for developing devices for vocalization reinforcement and for programming language input was predicated on the assumption that adequate vocal reinforcement and speech models could not be provided by the deaf parent. An alternate approach to the development of mechanical devices is to approach the problem by training the deaf parent to better meet these needs.

Vocal Perception of Deaf Parents

An experiment was conducted to evaluate the ability of deaf parents to perceive their infants' vocalizations and the extent to which this might be improved by training. Eleven deaf parents (10 mothers and one father), each the principal caretaker, participated with their infants in the study. Four of the infants were hearing and the seven others deaf. Age range of the infants was from 7 months to 3 years. Each parent participated in four 10-minute sessions during which they were asked to press a button whenever they thought their child was vocalizing and to release it when the vocalization stopped. During two sessions the parents were unaided, while in the other two sessions the parents wore a headset connected to an amplifier, which they controlled to their own comfort level. Aided and unaided conditions were administered in counterbalanced order. During the 10-minute session, one E engaged the infant in play such that the infant's face was visible to the parent, who sat a few feet from the infant in an observation playroom. A second E recorded the infant's vocalizations on chart and tape recorders from behind a one-way mirror. Only sessions in which there were at least 10 infant vocalizations were included in the analysis.

Each of the 600 seconds of the experiment were scored as correct or incorrect. The parent's vocal perception accuracy score consisted of the percentage of infant vocalizations correctly detected minus the percentage of non-vocalization seconds during which the parent reported a vocalization as having occurred.

The results of a 2 x 2 (conditions by sessions) factorial analysis of variance of vocal perception accuracy scores is presented in Table 18.

Table 18

ANOVA of Vocal Perception Accuracy Scores

	df	MS	F
Between Ss	10	998.40	
Within Ss	33		
A(Aided vs. Unaided)	1	5069.92	13.94**
A x Ssw. gps	10	363.59	
B(First vs. Second Session)	1	222.70	< 1
B x Ss w. gps	10	668.95	
A x B	1	1124.44	7.94*
A x B x Ss w. gps	10	141.60	

*$p < .05$
**$p < .01$

Mean accuracy scores were 26.17% for the unaided vs. 47.63% for the aided condition. This improvement with amplification is highly significant ($F = 13.94$, $p < .01$). The significant interaction effect ($F = 7.94$, $p < .05$) is attributable to an improvement, probably due to practice, from the first unaided session (Mean = 18.86%) to the second (Mean = 33.47%), while there was no significant improvement from the first to second aided session (Means of 48.56% and 46.80% respectively).

The results confirm anecdotal reports in the literature that deaf parents are extremely poor judges of their infants' vocalizations. They are thus likely to be poor at providing

social or other reinforcement for infant vocal production. Amplification results in a significant improvement in accuracy.

The implications of these findings are that auditory training provided to deaf parents is likely to have direct effects on the child by improving the parents' effectiveness as a reinforcing agent. In addition, since children acquire speech through imitation of parental models, the combination of amplification and speech training of parents is likely to have a powerful influence on the child's speech competence.

Auditory and speech training of deaf parents

To investigate this possibility further, two deaf mothers were fitted with hearing aids and attended weekly aural rehabilitation sessions at the Infant Center. In addition, they were loaned Audio Flashcard readers for home speech practice. The goals of this program were: (a) to improve the parents' awareness of when their children are vocalizing so that they can act as more effective reinforcing agents, and (b) to increase and improve the deaf parents' use of speech so as to provide a more effective speech model for the child.

Both mothers had participated in the study of deaf parents' perception of infant vocalization. Perception of infant vocalization scores were obtained at three and eight months after receiving hearing aids. Data were as follows:

	Before Owning Aid		With Own Aid	
	Unaided	Aided	At 3 mos.	At 8 mos.
Mother 1	22.46%	28.79%	59.15%	48.80%
Mother 2	0%	41.26%	67.70%	52.10%

Although statistical significance cannot be assessed with so small a sample, it is apparent that these two mothers improved from a position of near total inability to determine when their infants were vocalizing to one in which they were able to do so more than half of the time.

It is apparent that additional improvement did not take place in the last five months. Experience with a hearing aid improved the parents' ability to detect the vocalizations as seen by the improvement between the initial aided condition and after three months of wearing the aids; however, additional

auditory training did not improve this ability further.

The parents felt that they benefitted from the hearing aids and training in that they became more aware of their children's use of speech. The following was written by one of the mothers:

> Wearing two hearing aids daily is more beneficial than expected because it helps me find out whether or not my deaf children use their voices. We cannot be fooled. In other words, with my reminder, they have formed a habit of using their voices. As a result they have developed their confidence of speaking with their hearing peers. Another asset is that it helps us control our pitches. My husband did not realize that he used a low voice or pitch until he heard himself with the aids. With the aids we become aware of hearing who is talking with one another whenever we want to talk with one of them. Psychologically, hearing people treat you like a hearing person when they see you wearing a hearing aid. Practicing one's speech daily is ideal, but it is costly to have a speech teacher.

It was not possible to objectively measure the effectiveness of the aural rehabilitation program. The parents' speech improved in the context of specific training sessions but spontaneous speech was unchanged.

CHAPTER VII

DISCUSSION

The goal of the project has been to study ways in which educators may foster the acquisition of speech and language in deaf infants. Part I has concerned itself with studies of the efficacy of early intervention and on ways in which facilitating aspects of mother-infant interaction may be identified. In its original aim, Part II concerned itself with the development of innovative devices which might facilitate vocal production and oral receptive language, particularly in the infant from a deaf home. As first conceived, a "kit" of such devices, with appropriate curricular materials, might be developed for use with such infants.

In adopting this point of view, the principal investigator was influenced by "space age thinking," the peculiarly American view that seeks the solution to vexing problems through technology and gadgetry.

From the limited pilot research described earlier, it is clear that some hearing-impaired children under three years of age can be conditioned to increase their vocalization rates for the visual reinforcement provided by the Deci-Bear. However, there is no evidence that this device is more than an interesting, perhaps temporarily distracting toy for the deaf child.

It seems that the language playboard, originally designed to provide receptive language for the hearing-impaired child under three, will not maintain attention without social reinforcement. Neither toy manipulation nor the auditory feedback associated with lever pressing is sufficiently reinforcing to induce the young deaf child to play with the language playboard on his/her own. As a self-teaching device it simply does not work. Perhaps the most effective use of the language playboard would be as an auditory training device by a parent or teacher to develop listening skills and vocabulary. Our pilot work suggests that after the 3-year-old has been thoroughly trained to listen for the auditory message, minimal social reinforcement (nods and smiles) may suffice to keep the child within the learning situation. As such, the language playboard is potentially a useful auditory training

device for deaf parents. Even with a teacher or parent providing social reinforcement the language playboard cannot provide useful receptive language if the child has not learned to attend to auditory stimuli. Though children as young as 2 years will play with the language playboard along with their mothers, the listening skills which are a prerequisite for auditory discrimination of language do not seem to be sufficiently developed to effectively use the playboard until after three years of age.

In view of the numerous technical difficulties posed by the development of automatic devices and their limited applicability, an educationally more effective approach might be to focus more upon training parents rather than infants. Certainly, the work conducted on this project suggests agreement with Boothroyd's (1975) formulation:

> There is, of course, no technological substitute for a good teacher, nor can gadgets make good teachers out of bad teachers. Nevertheless, a discriminating teacher can find many useful devices and a wealth of instructional materials to aid in the teaching task (p. 29).

For the deaf child from a deaf home, resources would certainly be better devoted to auditory-vocal training of parents. As a result of the pilot work done at the Infant Center, the Lexington School for the Deaf has instituted a program of providing loaner aids and auditory training to all willing deaf parents in its infant program.

The value of a parent aural rehabilitation program is that it increases the parents' concern and awareness about the speech of their children. Most deaf parents do not wear hearing aids because as teenagers they rejected the poorer quality and larger size hearing aids that were popular when they were children. A program that effectively introduces deaf parents to modern day hearing aids and that heightens speech awareness is clearly an important aspect of an effort to promote use of speech for the deaf child.

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APPENDIX A

LEXINGTON PRESCHOOL ORAL LANGUAGE ASSESSMENT (POLA)

LEXINGTON PRESCHOOL ORAL LANGUAGE ASSESSMENT (POLA)

Introduction:

The Lexington Preschool Oral Language Assessment is a procedure designed to measure the speech and language competence of three-year-old hearing-impaired children. Designed for children who are currently aided and who have received some previous auditory training, the procedure resembles a familiar play situation with an adult tutor.

Scales:

The POLA consists of 311 scorable items which are classified into four categories. The initials D, A, E, or I before each item stand for the following:

D = Directions. These items are orally given requests for the child to perform. They are spoken only when the child is attentive and looking at the face of the examiner.

A = Auditory directions. These directions, given to assess the child's use of residual hearing, are spoken with the hand masking the lips. The underlined word is the one concealed in these items.

E = Elicitations. These are questions or actions aimed at eliciting spontaneous oral responses from the child.

I = Imitations. These are words spoken in an effort to elicit vocal imitation from the child.

Items in the D and A Scales assess receptive oral-aural language competence. Items in the E and I Scales assess expressive oral language competence.

Scoring:

The child's oral response to each E or I item is written in IPA on the line to the right of each item.

These items are scored:

0 = No oral response (or a random vocalization)
1 = An oral response which is non-random but unintelligible as a word in the context

2 = An oral response containing at least one correct phoneme or intelligible as an appropriate word in the context.

Directions (A or D items) are scored:

0 = No response
1 = A possibly appropriate but incorrect response
2 = A correct response to the direction

Materials Required:

1. Jack-in-the-box
2. *Baby doll (dressed with following clothing)
   (a) hat
   (b) coat
   (c) pants
   (d) shoes
   (e) socks
   (f) shirt
3. *Bathtub
4. Cup of water
5. Washcloth
6. Soap
7. Towel
8. "Magic Nurser" bottle
9. Pajamas
10. *Blanket, bed and pillow
11. *Small green car
12. *Large orange car
13. Small pliable family dolls
   (a) mother
   (b) father
   (c) girl
   (d) boy
   (e) baby
14. *Airplane
15. Flashlight (with red light)
16. Ball (with yellow, blue and red colors)
17. *Two telephones
18. Latchbox with four doors containing:
   (a) bird
   (b) cat (holding ball)
   (c) cow
   (d) dog
19. Story book:
   Bobbie Had a Nickel by Frieda Friedman. (Kenosha, Wisc. Samuel Lowe Co., 1970).

20. Box containing:
    (a) 2 lollipops (red and green)
    (b) toy ice cream cone
    (c) plastic soap bubble bottle
    (d) boat
    (e) 2 cookies
    (f) yellow balloon
    (g) truck

* Asterisked items are wrapped in plastic wastebasket bags so as not to be identifiable until opened.

Other items are placed in and removed from a small cardboard box.

LEXINGTON PRESCHOOL ORAL LANGUAGE ASSESSMENT

(Enter room with child)

D 1.	SIT DOWN	0 1 2	
	(Jack-in-the-box)		
E 2.	WHAT'S IN THERE?	0 1 2	_____
D 3.	PUSH THE BUTTON.	0 1 2	
E 4.	WHAT HAPPENED?	0 1 2	_____
E 5.	HE CAME...	0 1 2	_____
I 6.	HE CAME UP.	0 1 2	_____
	(Point to eyes)		
E 7.	WHAT'S THAT?	0 1 2	_____
I 8.	EYES.	0 1 2	_____
	(Point to nose)		
E 9.	WHAT'S THAT?	0 1 2	_____
I 10.	NOSE.	0 1 2	_____
	(Point to mouth)		
E 11.	WHAT'S THAT?	0 1 2	_____
I 12.	MOUTH.	0 1 2	_____
D 13.	MAKE IT GO DOWN. PUSH.	0 1 2	

(Baby bag)

E 14. WHAT'S INSIDE? 0 1 2 _____

(Remove baby)

E 15. WHAT'S THAT? 0 1 2 _____

I 16. A BABY. 0 1 2 _____

(Point to:)

E 17. (hat) WHAT'S THAT? 0 1 2 _____

I 18. HAT. 0 1 2 _____

E 19. (coat) WHAT'S THAT? 0 1 2 _____

I 20. COAT. 0 1 2 _____

E 21. (pants) WHAT'S THAT? 0 1 2 _____

I 22. PANTS. 0 1 2 _____

E 23. (shoes) WHAT'S THAT? 0 1 2 _____

I 24. SHOES. 0 1 2 _____

A 25. TAKE OFF THE BABY'S HAT. 0 1 2

D 26. TAKE OFF THE BABY'S HAT. 0 1 2

A 27. TAKE OFF THE BABY'S SHOES. 0 1 2

D 28. TAKE OFF THE BABY'S SHOES. 0 1 2

A 29. TAKE OFF THE BABY'S COAT. 0 1 2

D 30. TAKE OFF THE BABY'S COAT. 0 1 2

A	31.	TAKE OFF THE BABY'S <u>SOCKS</u>.	0 1 2	
D	32.	TAKE OFF THE BABY'S SOCKS.	0 1 2	
A	33.	TAKE OFF THE BABY'S <u>PANTS</u>.	0 1 2	
D	34.	TAKE OFF THE BABY'S PANTS.	0 1 2	
E	35.	TAKE IT ...	0 1 2	_____
I	36.	TAKE IT OFF.	0 1 2	_____
D	37.	TAKE OFF BABY'S SHIRT.	0 1 2	
E	38.	LOOK, BABY IS DIRTY. WHAT ARE WE GOING TO DO?	0 1 2	_____

(<u>Bathtub bag</u>)

E	39.	WHAT DO YOU DO? (Prevent child from opening bag)	0 1 2	_____
I	40.	OPEN.	0 1 2	_____
E	41.	WHAT IS IT?	0 1 2	_____
I	42.	BATHTUB.	0 1 2	_____

(Take water cup)

E	43.	A BATHTUB FOR THE ...	0 1 2	_____
I	44.	BABY.	0 1 2	_____
E	45.	(Holds cup) WHAT'S THIS?	0 1 2	_____
I	46.	CUP.	0 1 2	_____
E	47.	WHAT'S IN IT?	0 1 2	_____

I	48.	WATER.	0 1 2	_____
D	49.	POUR THE WATER IN THE BATHTUB.	0 1 2	
D	50.	PUT THE BABY IN THE BATHTUB.	0 1 2	
E	51.	(Washcloth) WHAT'S THIS?	0 1 2	_____
I	52.	WASHCLOTH.	0 1 2	_____
E	53.	(Soap) WHAT'S THIS?	0 1 2	_____
I	54.	SOAP.	0 1 2	_____
D	55.	MAKE THE WASHCLOTH WET.	0 1 2	
D	56.	PUT THE SOAP ON THE WASHCLOTH.	0 1 2	
A	57.	WASH THE BABY'S <u>EYES</u>.	0 1 2	
D	58.	WASH THE BABY'S EYES.	0 1 2	
A	59.	WASH THE BABY'S <u>NOSE</u>.	0 1 2	
D	60.	WASH THE BABY'S NOSE.	0 1 2	
A	61.	WASH THE BABY'S <u>MOUTH</u>.	0 1 2	
D	62.	WASH THE BABY'S MOUTH.	0 1 2	
A	63.	WASH THE BABY'S <u>HAIR</u>.	0 1 2	
D	64.	WASH THE BABY'S HAIR.	0 1 2	

A 65. WASH THE BABY'S FEET. 0 1 2

D 66. WASH THE BABY'S FEET. 0 1 2

(Take baby out of tub)

E 67. OH. BABY IS ALL ... 0 1 2 _____

I 68. WET. 0 1 2 _____

(Put towel in box)

E 69. WHAT ARE YOU GOING TO DO? 0 1 2 _____

I 70. PULL. 0 1 2 _____

E 71. WHAT'S THAT? 0 1 2 _____

I 72. TOWEL. 0 1 2 _____

E 73. WHAT ARE YOU GOING TO DO? 0 1 2 _____

D 74. DRY THE BABY. 0 1 2

E 75. NOW BABY IS ALL ... 0 1 2 _____

I 76. DRY. 0 1 2 _____

(Put bottle in box)

E 77. NOW BABY SAY'S "I'M HUNGRY. I WANT SOMETHING TO EAT. WE'RE GOING TO ... 0 1 2 _____

I 78. FEED BABY. 0 1 2 _____

E	79.	(bottle) WHAT'S THAT?	0 1 2	_____
I	80.	BOTTLE.	0 1 2	_____
E	81.	WHAT'S INSIDE?	0 1 2	_____
I	82.	MILK.	0 1 2	_____
A	83.	FEED THE BABY.	0 1 2	
D	84.	GIVE THE BABY THE MILK.	0 1 2	
		(Milk goes down)		
E	85.	WHAT HAPPENED?	0 1 2	_____
I	86.	NO MORE.	0 1 2	_____
E	87.	DO YOU WANT MORE?	0 1 2	_____
I	88.	MORE MILK.	0 1 2	_____
		(Produce more milk)		
E	89.	WHAT HAPPENED?	0 1 2	_____
I	90.	MORE MILK.	0 1 2	_____
E	91.	NOW BABY IS TIRED. HE WANTS TO GO TO ...	0 1 2	_____
I	92.	SLEEP.	0 1 2	_____
		(Pajamas in box)		
D	93.	PULL IT OUT.	0 1 2	
E	94.	WHAT'S THAT?	0 1 2	_____

I 95. PAJAMAS. 0 1 2 _____

D 96. PUT THE PAJAMAS ON BABY. 0 1 2

(Blanket bag)

E 97. WHAT ARE YOU GOING TO DO? 0 1 2 _____

I 98. OPEN. 0 1 2 _____

E 99. (Bed) WHAT'S THAT? 0 1 2 _____

I 100. BED. 0 1 2 _____

D 101. PUT THE BABY ON THE BED. 0 1 2 _____

E 102. (Pillow) WHAT'S THAT? 0 1 2 _____

I 103. PILLOW. 0 1 2 _____

D 104. PUT THE PILLOW UNDER BABY'S HEAD. 0 1 2

E 105. BABY IS COLD. WHAT DOES HE NEED? 0 1 2 _____

E 106. (Blanket) WHAT'S THAT? 0 1 2 _____

I 107. BLANKET. 0 1 2 _____

D 108. COVER THE BABY. PUT THE BLANKET ON THE BABY. 0 1 2

E 109. SHH. WHAT IS BABY DOING? 0 1 2 _____

I 110. SLEEPING 0 1 2 _____

D 111. PUT THE BABY ON THE FLOOR. 0 1 2

(Small car bag)

E 112. WHAT DO WE DO? 0 1 2 _____

I 113. OPEN. 0 1 2 _____

E 114. WHAT IS IT? 0 1 2 _____

I 115. A CAR. 0 1 2 _____

E 116. WHAT COLOR IS IT? 0 1 2 _____

I 117. GREEN. 0 1 2 _____

E 118. LET'S MAKE THE CAR... 0 1 2 _____

I 119. GO. 0 1 2 _____

(Say, "one", hold up one finger.)

E 120. (Hold up two fingers.) 0 1 2 _____

I 121. TWO. 0 1 2 _____

E 122. (Hold up three fingers.) 0 1 2 _____

I 123. THREE. 0 1 2 _____

I 124. GO. 0 1 2 _____

(Make car go. Stop it.)

E 125. WHAT HAPPENED? I MADE IT... 0 1 2 _____

I 126. STOP. 0 1 2 _____

(Big car bag)

E 127.	(Hold closed. Wait for "open.")	0 1 2	_____
I 128.	OPEN.	0 1 2	_____
E 129.	WHAT'S THAT?	0 1 2	_____
I 130.	ANOTHER CAR.	0 1 2	_____
E 131.	WHAT COLOR IS IT?	0 1 2	_____
I 132.	ORANGE.	0 1 2	_____
E 133.	WHERE IS THE SMALL CAR?	0 1 2	_____
E 134.	THIS CAR IS SMALL. THIS CAR IS ...	0 1 2	_____
I 135.	BIG.	0 1 2	_____
D 136.	WHICH IS THE SMALL CAR?	0 1 2	
D 137.	MAKE THE BIG CAR GO.	0 1 2	
D 138.	PUT THE SMALL CAR UNDER THE TABLE.	0 1 2	

(Put Family dolls in box)

E 139.	LOOK. WHO IS THAT?	0 1 2	_____
I 140.	MOMMY.	0 1 2	_____
E 141.	AND WHO'S THAT?	0 1 2	_____

I 142.	DADDY.	0 1 2	_____
E 143.	WHO'S THAT?	0 1 2	_____
I 144.	BOY.	0 1 2	_____
E 145.	WHO'S THAT?	0 1 2	_____
I 146.	GIRL.	0 1 2	_____
A 147.	PUT MOMMY IN THE CAR.	0 1 2	
D 148.	PUT MOMMY IN THE CAR.	0 1 2	
D 149.	MAKE MOMMY SIT DOWN.	0 1 2	
D 150.	PUT THE BOY IN THE BACK OF THE CAR.	0 1 2	
A 151.	PUT DADDY IN THE CAR.	0 1 2	
D 152.	PUT DADDY IN THE CAR.	0 1 2	
A 153.	PUT THE BABY IN THE CAR.	0 1 2	
D 154.	PUT THE BABY IN THE CAR.	0 1 2	
D 155.	GIVE THE BABY TO MOMMY.	0 1 2	
D 156.	PUT THE GIRL NEXT TO THE BOY.	0 1 2	
E 157.	THEY'RE GOING AWAY. WHAT DO YOU SAY? (Wave.)	0 1 2	_____
I 158.	BYE-BYE.	0 1 2	_____
D 159.	MAKE THE CAR GO FAST.	0 1 2	
D 160.	MAKE THE CAR GO SLOW.	0 1 2	

A 161. MAKE IT STOP. 0 1 2

D 162. MAKE IT STOP. 0 1 2

(Airplane bag)

E 163. (Hold closed. Wait for "open.") 0 1 2 _____

I 164. OPEN. 0 1 2 _____

E 165. WHAT'S THAT? 0 1 2 _____

I 166. AIRPLANE. 0 1 2 _____

E 167. LET'S MAKE IT... 0 1 2 _____

I 168. FLY. 0 1 2 _____

E 169. LOOK IT'S GOING... 0 1 2 _____

I 170. UP. 0 1 2 _____

E 171. NOW IT'S GOING... 0 1 2 _____

I 172. DOWN. 0 1 2 _____

A 173. MAKE IT GO UP. 0 1 2

D 174. MAKE IT GO UP. 0 1 2

A 175. MAKE IT GO DOWN. 0 1 2

D 176. MAKE IT GO DOWN. 0 1 2

(Put Flashlight in box)

E 177. WHAT'S THAT? 0 1 2 _____

I 178. LIGHT. 0 1 2 _____

A 179. TURN IT ON. PUSH. 0 1 2

D 180. TURN IT ON. PUSH. 0 1 2

E 181. WHAT COLOR IS IT? 0 1 2 _____

A 182. TURN IT OFF. 0 1 2

D 183. TURN IT OFF. 0 1 2

A 184. OPEN YOUR MOUTH. 0 1 2

D 185. OPEN YOUR MOUTH. 0 1 2

(Shine light in.)

(Put Ball in box.)

E 186. WHAT'S THAT? 0 1 2 _____

I 187. BALL. 0 1 2 _____

E 188. WHAT COLOR? 0 1 2 _____

I 189. YELLOW. 0 1 2 _____

E 190. WHAT COLOR? 0 1 2 _____

I 191. BLUE. 0 1 2 _____

E 192. (Point to red) 0 1 2 _____

I 193. RED. 0 1 2 _____

E 194. (Roll ball) WHAT DID I DO? 0 1 2 _____

I 195. ROLL THE BALL. 0 1 2 _____

D 196.	ROLL THE BALL TO ME.	0 1 2	
A 197.	MAKE THE BALL GO UP.	0 1 2	
D 198.	MAKE THE BALL GO UP.	0 1 2	
D 199.	CAN YOU SQUEEZE THE BALL? SQUEEZE THE BALL.	0 1 2	
D 200.	PUT THE BALL IN THE BOX.	0 1 2	
D 201.	PUT THE BOX ON THE FLOOR.	0 1 2	
	(Telephone bag)		
E 202.	WHAT ARE THESE?	0 1 2	_____
I 203.	TELEPHONES.	0 1 2	_____
D 204.	PICK IT UP.	0 1 2	
E 205.	HELLO. WHAT'S YOUR NAME?	0 1 2	_____
I 206.	(Say child's name.)	0 1 2	_____
E 207.	ARE YOU A BOY OR A GIRL?	0 1 2	_____
I 208.	YOU'RE A (BOY/GIRL).	0 1 2	_____
D 209.	I'LL BE MOMMY. TALK TO MOMMY.	0 1 2	
E 210.	ARE YOU FINISHED?	0 1 2	_____
E 211.	WHAT DO YOU SAY? (wave)	0 1 2	_____
I 212.	BYE-BYE	0 1 2	_____

(Latchbox)

E 213.	LOOK AT THAT. WHAT DO YOU HAVE TO DO?	0 1 0 1 2	_____
I 214.	OPEN.	0 1 2	_____
E 215.	WHAT'S THAT?	0 1 2	_____
I 216.	BIRD.	0 1 2	_____
A 217.	LISTEN TO THE BIRD: TWEET.	0 1 2	_____
I 218.	TWEET.	0 1 2	_____
E 219.	WHAT DOES THE BIRD DO? (Demonstrate)	0 1 2	_____
I 220.	FLY.	0 1 2	_____
D 221.	MAKE THE BIRD FLY.	0 1 2	
A 222.	MAKE HIM GO UP.	0 1 2	
D 223.	MAKE HIM GO UP.	0 1 2	
A 224.	MAKE HIM GO DOWN.	0 1 2	
D 225.	MAKE HIM GO DOWN.	0 1 2	
D 226.	PUT IT BACK.	0 1 2	
D 227.	CLOSE IT.	0 1 2	

(Cat)

E 228.	(Wait for "open".)	0 1 2	_____

E 229. WHAT'S THAT? 0 1 2 _____

I 230. CAT. 0 1 2 _____

E 231. WHAT'S THE CAT PLAYING WITH? 0 1 2 _____

I 232. BALL. 0 1 2 _____

A 233. MAKE THE BALL GO ROUND. 0 1 2

D 234. MAKE THE BALL GO ROUND. 0 1 2

A 235. LISTEN TO THE CAT: MEOW. 0 1 2 _____

I 236. MEOW. 0 1 2 _____

D 237. MAKE THE CAT WALK. 0 1 2

E 238. (Make cat fall.) WHAT HAPPENED? 0 1 2 _____

I 239. HE FELL DOWN. 0 1 2 _____

A 240. PUT THE CAT BACK. 0 1 2

D 241. PUT THE CAT BACK. 0 1 2

D 242. CLOSE IT. 0 1 2

(Cow)

E 243. (Wait for "open".) 0 1 2 _____

E 244. WHAT'S THAT? 0 1 2 _____

I 245. COW. 0 1 2 _____

A 246. LISTEN TO THE COW: MOO 0 1 2 _____

I 247.	MOO.	0 1 2	_____
E 248.	LOOK AT THE COW...(Demonstrate walking) WHAT IS HE DOING?	0 1 2	_____
I 249.	WALK.	0 1 2	_____
E 250.	(Cow falls) WHAT HAPPENED?	0 1 2	_____
I 251.	HE FELL DOWN.	0 1 2	_____
A 252.	PUT THE COW BACK.	0 1 2	
D 253.	PUT THE COW BACK.	0 1 2	

(Dog)

E 254.	(Wait for "open")	0 1 2	_____
E 255.	WHAT'S THAT?	0 1 2	_____
I 256.	DOG.	0 1 2	_____
A 257.	LISTEN TO THE DOG: BOW-WOW.	0 1 2	_____
I 258.	BOW-WOW.	0 1 2	_____
E 259.	LOOK AT THE DOG...(walk) WHAT IS HE DOING?	0 1 2	_____
I 260.	WALK.	0 1 2	_____
E 261.	(Dog falls) WHAT HAPPENED?	0 1 2	_____
I 262.	HE FELL DOWN.	0 1 2	_____
A 263.	PUT THE DOG BACK.	0 1 2	
D 264.	PUT THE DOG BACK.	0 1 2	

STORY

NOW WE HAVE A STORY. THERE'S A LITTLE BOY. AND HE HAS A NICKEL. (Show) AND HE'S THINKING: "WHAT AM I GOING TO BUY?" HE SAYS: "MAYBE I'LL BUY..."

E 265.	(Show lollipop.)	0 1 2	_____
I 266.	LOLLIPOP.	0 1 2	_____
E 267.	(Show ice cream.)	0 1 2	_____
I 268.	ICE CREAM.	0 1 2	_____
E 269.	(Show bubbles.)	0 1 2	_____
I 270.	BUBBLES.	0 1 2	_____
E 271.	(Show boat.)	0 1 2	_____
I 272.	BOAT.	0 1 2	_____
E 273.	(Show cookies.)	0 1 2	_____
I 274.	COOKIES.	0 1 2	_____
E 275.	(Show balloon.)	0 1 2	_____
I 276.	BALLOON.	0 1 2	_____
E 277.	WHAT COLOR IS IT?	0 1 2	_____
I 278.	YELLOW.	0 1 2	_____
E 279.	(Show truck.)	0 1 2	_____
I 280.	TRUCK.	0 1 2	____

AND HE SITS DOWN AND HE'S THINKING: WHAT AM I GOING TO BUY? WILL I BUY THE...

E 281.	(Point to the truck.)	0 1 2	_____
I 282.	TRUCK.	0 1 2	_____
E 283.	(Point to lollipop.)	0 1 2	_____
I 284.	LOLLIPOP.	0 1 2	_____
E 285.	(Point to bubbles.)	0 1 2	_____
I 286.	BUBBLES.	0 1 2	_____
E 287.	(Point to ice cream.)	0 1 2	_____
I 288.	ICE CREAM.	0 1 2	_____
E 289.	(Point to boat.)	0 1 2	_____
I 290.	BOAT.	0 1 2	_____
E 291.	(Point to cookies.)	0 1 2	_____
I 292.	COOKIES.	0 1 2	_____
E 293.	(Point to balloon.)	0 1 2	_____
I 294.	BALLOON.	0 1 2	_____

HE SAYS: "I DON'T KNOW." AND HE'S THINKING AND THINKING. BUT HE DOESN'T BUY ANY OF THEM. HE GOES ON A MERRY-GO-ROUND.

E 295. AND HE'S GOING...(dem. Round) 0 1 2 _____

I 296. ROUND. 0 1 2 _____

HE DOESN'T BUY ANY OF THESE. SO WE HAVE TO PUT EVERYTHING BACK.

(Take box.)

A 297. PUT THE BOAT IN THE BOX. 0 1 2

D 298. PUT THE BOAT IN THE BOX. 0 1 2

A 299. THEN THE BUBBLES. 0 1 2

D 300. THEN THE BUBBLES. 0 1 2

A 301. THEN THE ICE CREAM. 0 1 2

D 302. THEN THE ICE CREAM. 0 1 2

A 303. THEN THE COOKIES. 0 1 2

D 304. THEN THE COOKIES. 0 1 2

A 305. THEN THE BALLOON. 0 1 2

D 306. THEN THE BALLOON. 0 1 2

A 307. THEN THE TRUCK. 0 1 2

D 308. THEN THE TRUCK. 0 1 2

D 309. THEN THE LOLLIPOP. BUT YOU CAN HAVE ONE. WHICH ONE DO YOU WANT? 0 1 2

E 310. WHAT DO YOU SAY? 0 1 2 _____

I 311. THANK YOU. 89 0 1 2 _____

APPENDIX B

MOTHER-INFANT COMMUNICATION RATING SCALES

Name of Child _____

Name of Rater _____

Date _____

Mother-Infant Communication Rating Scales

Circle the number corresponding to the appropriate rating:

1 = Poor
2 = Below Average
3 = Average
4 = Above Average
5 = Excellent

A. Mother's Language Behavior

	Poor		Average		Excellent
1. Loudness of voice	1	2	3	4	5
2. Variety in pitch and loudness	1	2	3	4	5
3. Clarity of speech	1	2	3	4	5
4. Rate of speech	1	2	3	4	5
5. Appropriateness of vocabulary	1	2	3	4	5
6. Uses optimal sentence length	1	2	3	4	5
7. Elicits language from child	1	2	3	4	5
8. Rewards child's verbal efforts	1	2	3	4	5
9. Expands child's language	1	2	3	4	5
10. Encourages language imitation	1	2	3	4	5
11. Relates language to child's actions	1	2	3	4	5
12. Uses voice to attract child's attention	1	2	3	4	5
13. Uses gestures to explain sound meanings	1	2	3	4	5
14. Makes speech highly visible	1	2	3	4	5
15. Speaks to child often	1	2	3	4	5

B. Mother's Relation to Child

	Poor		Average		Excellent
16. Emotional acceptance of child	1	2	3	4	5
17. Realistic about child's potential	1	2	3	4	5
18. Ability to motivate without coercion	1	2	3	4	5
19. Expression of warmth and affection	1	2	3	4	5
20. Encourages independence in child	1	2	3	4	5
21. Amount of interaction with child	1	2	3	4	5
22. Sensitivity to child's needs	1	2	3	4	5
23. Ease in managing child's behavior	1	2	3	4	5
24. Creativity in playing with child	1	2	3	4	5
25. Ease in relating to child	1	2	3	4	5
26. Apparent enjoyment of child	1	2	3	4	5
27. Smoothness of flow of communication	1	2	3	4	5

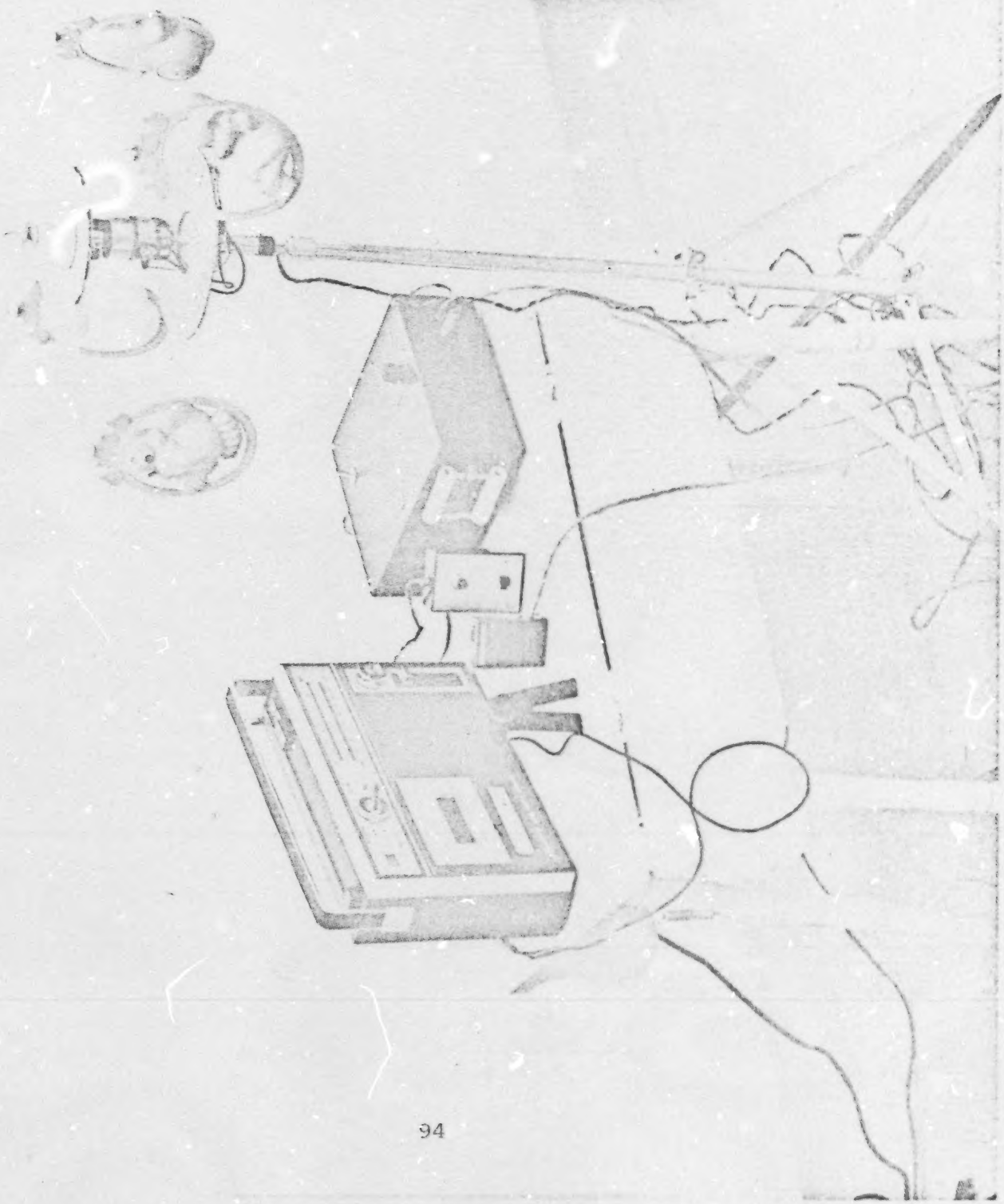
C. Mother's Response to Infant Center Program

28. Attendance in program	1	2	3	4	5
29. Maintaining optimal hearing aid performance	1	2	3	4	5
30. Home is optimal listening environment	1	2	3	4	5
31. Understands special needs of hearing-impaired child	1	2	3	4	5
32. Understands principles of child and language development	1	2	3	4	5
33. Cooperates with staff requests	1	2	3	4	5

APPENDIX C

DIAGRAMS OF NEW DEVICES

Figure 3 -
Voice-Activated Mobile



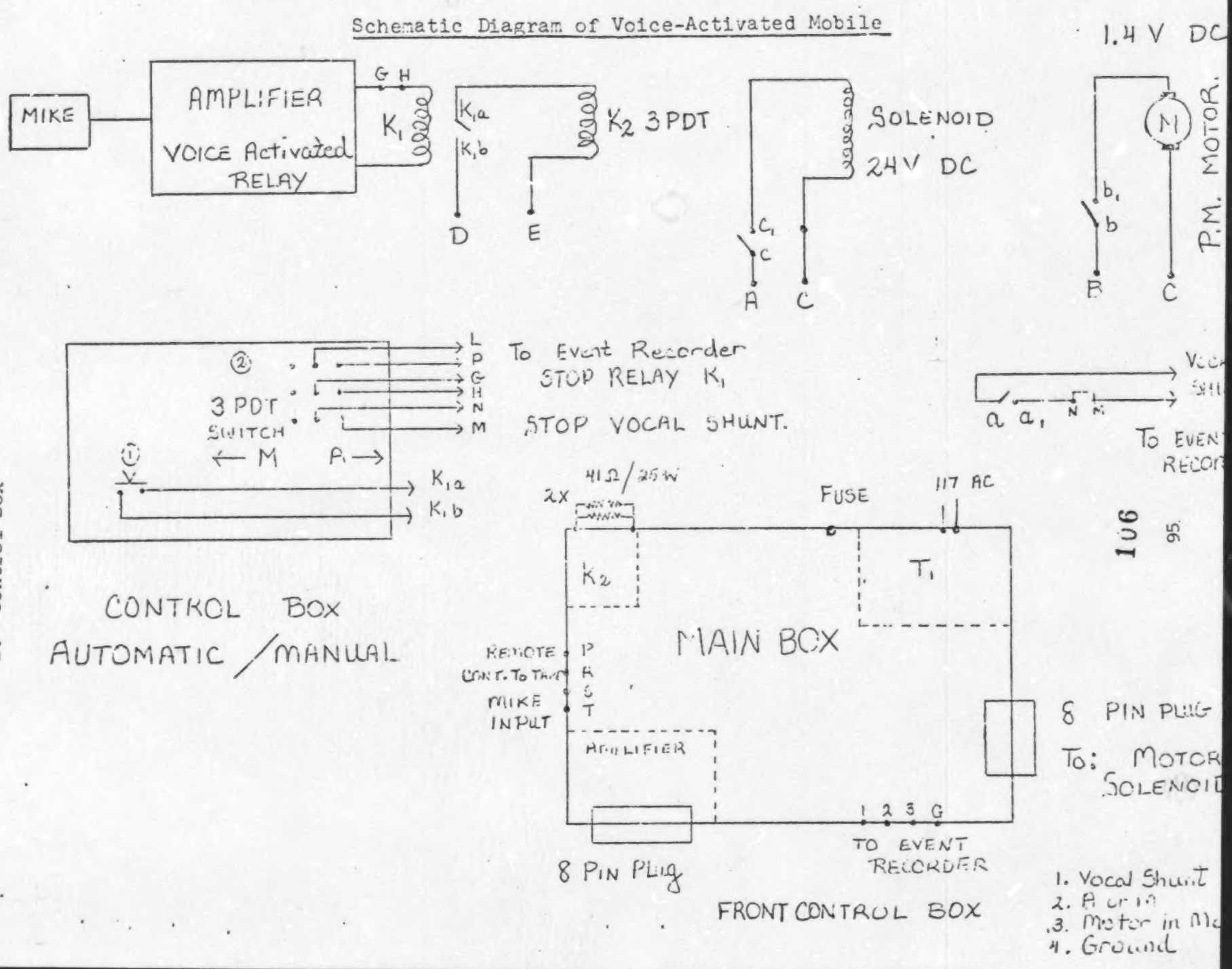


Figure 4 - Schematic Diagram of Voice-Activated Mobile:
I. Control Box

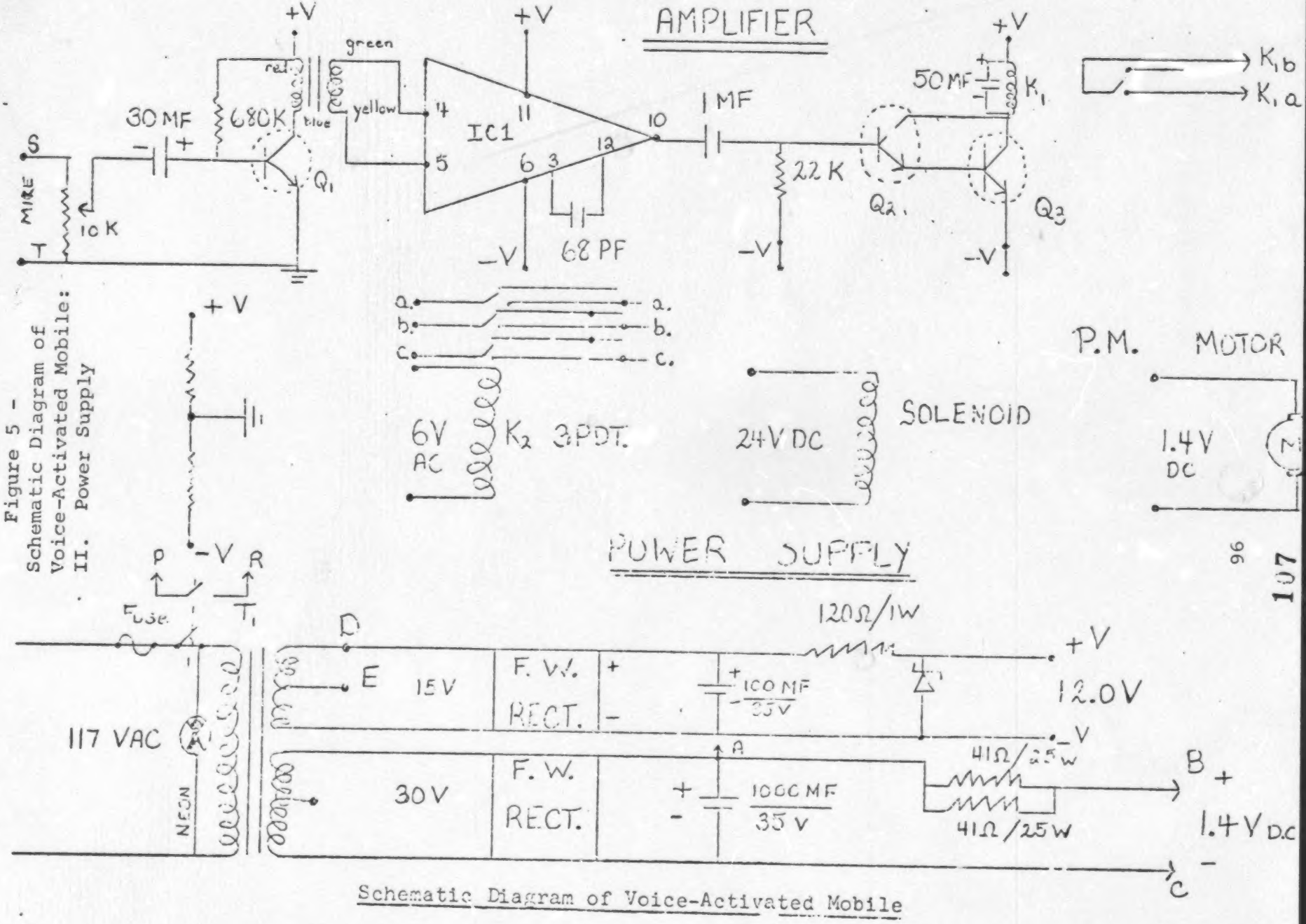


Figure 5 - Schematic Diagram of Voice-Activated Mobile: II. Power Supply

Schematic Diagram of Voice-Activated Mobile

Figure 6 -

"Desky," the Deci-Bear

Figure 7 - Switching Circuit for Deci-Bear

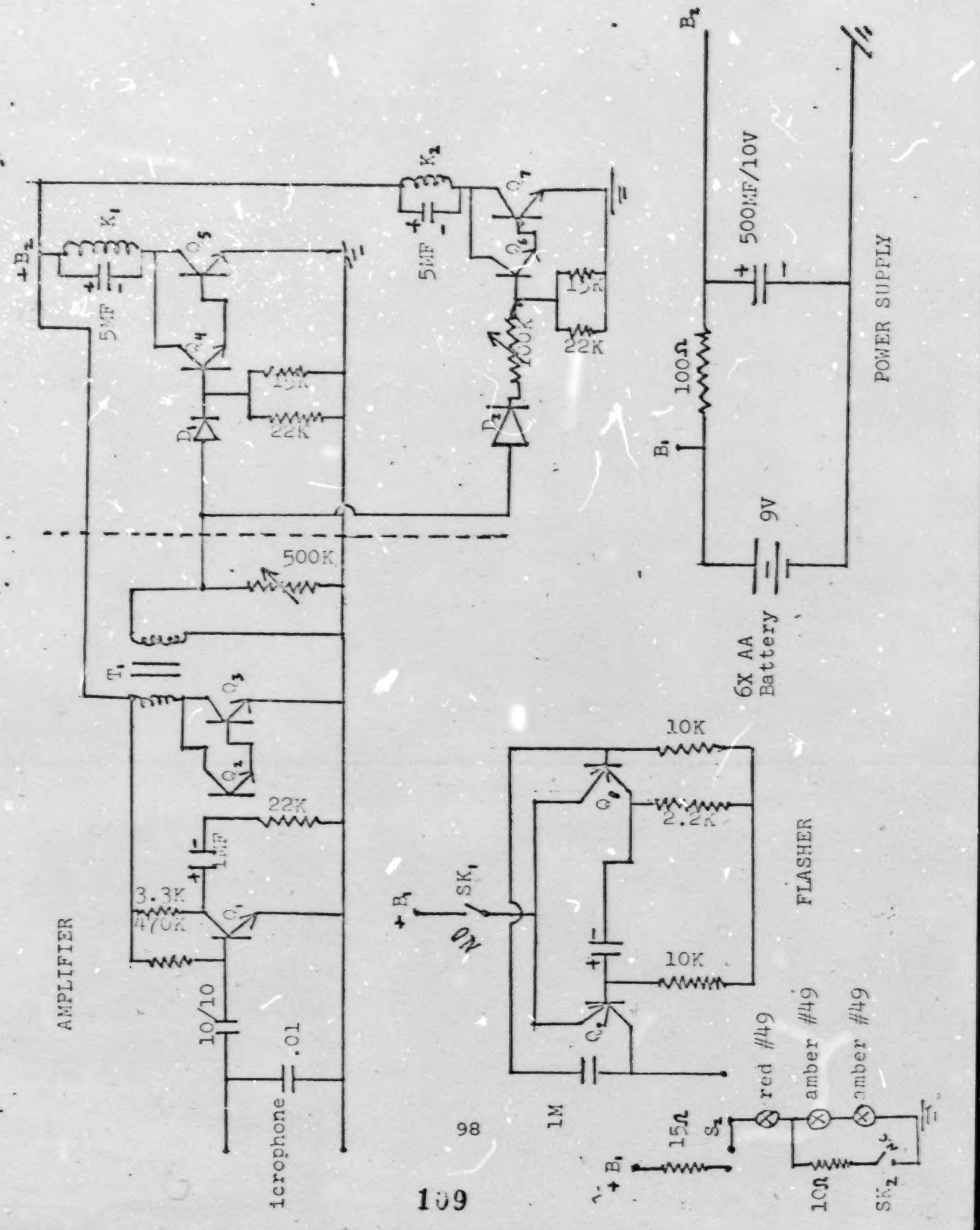


Figure 8 -

Language Playboard

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Figure 9 - Schematic Diagram of Language Playboard